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JACQUARDS AND HARNESSES

CARD-CUTTING, LACING AND REPEATING MECHANISM

BY

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AS A TRIBUTE TO HIS SUSTAINED INTEREST IN ALL BRANCHES OF EDUCATION, AND IN RECOGNITION OF HIS PERSONAL KINDNESS TO THE AUTHOR FOR NEARLY THIRTY YEARS.

PREFACE

THE specialisation of the literature of a subject very often proceeds unequally, so that whilst comprehensive treatises may be found in certain branches, the special treatment of others has not been adequately handled—an unequal development which has occurred in the literature of Textile Technology. The present volume is intended to remedy one such defect; it deals exhaustively with a large number of machines which are used for the preparation of jacquard cards for weaving carpets, damasks, tapestries, brocades, quilts, lace, and similar textures, and contains many elaborate designs with full instructions regarding harness ties, and all operations that are essential for the cutting, lacing, repeating, wiring, and repairing of jacquard cards. Particular attention is given to the various positions which the cards may occupy on right- and left-hand looms and to the changes required to produce the design correctly on the cloth.

Numerous figures (over 400, many of them large and full of detail) illustrative of the different pitches of machines have been introduced with the object of rendering the book useful to all who are engaged directly or indirectly in the manufacture of the various kinds of decorative textile fabrics.

The range of machines described and illustrated by photographs and line drawings is extensive, since it embodies several systems of card-cutting, and it is believed that few well-known machines have been omitted.

With the exception of twenty-nine new illustrations near the beginning of the book, and the relevant text, the whole of the work appeared serially from 1912 to 1923 in the *Textile Manufacturer*, while twenty-four illustrations have been introduced from the Author's work, *The Designing and Weaving of Decorative Fabrics*, which is still appearing serially in the above Journal.

The Author takes this opportunity of expressing his thanks to past and present colleagues of the Textile Department of the Dundee Technical College and School of Art for aid in the preparation of photographs, in the measurement of machinery, and in proof reading; to several Firms for kind permission to publish descriptions and photographs of machines; and to the publishers and printers for their consideration as the work was passing through their hands.

THOMAS WOODHOUSE.

DUNDEE, *August* 1923.

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CHAPTER I

INTRODUCTORY

From the point of view of weave structure, the manufacture of figured decorative textile fabrics necessitates the employment of more or less elaborate parts by means of which the customary jacquard cards, or their equivalents, may be punched or cut in order to complete the connection between the point-paper design and the actual shedding mechanism of the loom. This method of providing the selecting medium for the pattern is applicable to both hand and power looms, and there is perhaps no type of mechanism where more accuracy is required than in the various machines which are employed for the preparation of jacquard cards for the loom.

Although tappet looms are used mostly in the weaving of plain, twill, and similar fabrics where the weave effect is comparatively simple, and dobby looms are employed for the production of rather more complicated patterns on the surface of the cloth, the shedding apparatus of either or both of these types of loom may be desirable, and perhaps indispensable, in the production of certain types of decorative fabrics. And in some cases, one or both of these types of shedding may be used in conjunction with the jacquard.

A detailed description of the jacquard machine parts is not introduced, but it will be necessary to illustrate several of the chief parts of the jacquard in order to show, as clearly as possible, the connection between the jacquard itself and the cards which operate the needles; as is well known, these cards are prepared or punched by special machinery.

In the first case, it should be pointed out that, since the number of needles in a jacquard may vary from say 100 to 1300 or more, it is natural to find that the disposition of these needles in the various machines also varies. Thus, in what is known as the short row of the machine, and this is of more importance than the long row in regard to the preparation of the cards, there may be 4, 8, 10, 12, or 16 needles, and, consequently, provision on the jacquard card for a corresponding number of long rows of holes. The numbers in most frequent use are 8, 12, and 16; and since any of these numbers will suit our present purpose, we shall adopt the smallest number. This number, 8, is used in all so-called 400's jacquards.

These machines, which have 51 short rows, have evidently $51 \times 8 = 408$ needles and 408 hooks in the simplest kind of jacquard.

Figs. 1 and 2 represent respectively the first and last rows of such a machine, with the harness cords passing through the outermost row of eight holes in the comberboard. The figures, although partly diagram-

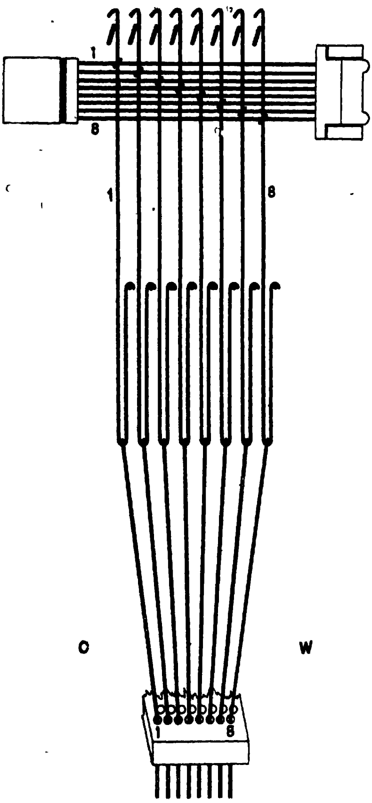


Fig. 1.

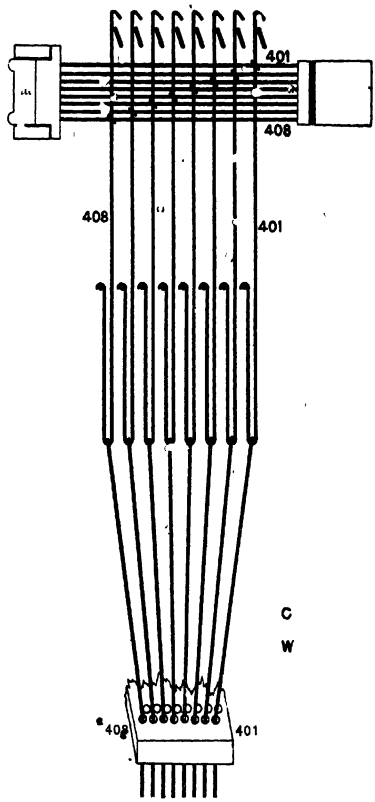


Fig. 2.

matic, are drawn to scale, with the exception of the thickness of the needles and hooks, and the distance between the bottom of the hooks and the top of the comberboard; this distance has been made short purposely to minimise the length of the drawings.

If the reader views the machine from one end of the loom he would see the first short row of needles and hooks, Nos. 1 to 8, as indicated in Fig. 1,

with the cylinder on the left-hand side. The view from the opposite end of the loom would be that of the last short row of needles and hooks, Nos. 401 to 408, and the cylinder on the right-hand side as in Fig. 2.

In practically all jacquard machines the top needle controls the hook nearest the needle board and cylinder, as shown by Nos. 1 and 401 in Figs. 1 and 2. The second needle down controls the second hook from the cylinder, and so on as indicated in both figures until the bottom row of needles is reached; hence, needles 8 and 408 control the hooks farthest away from the cylinder. If, therefore, the letter W, Fig. 1, represents the position of the weaver, the outside thread at the left of the warp must

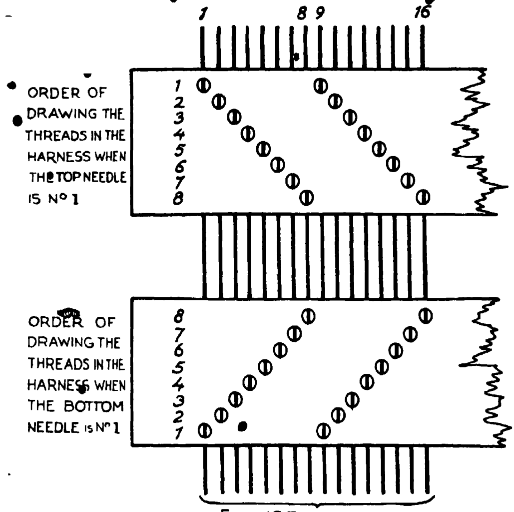


FIG. 3.

be drawn through the first mail belonging to the back long row of the comberboard.

The above is the method adopted in several districts, but in other districts, on the other hand, the bottom needle—the one marked No. 8 in Fig. 1—is considered as the first needle. In such a case, it is evident that the first thread on the weaver's left hand would be controlled by the hook marked No. 8. The two methods are illustrated diagrammatically in Fig. 3, with particulars on the left of the comberboard. It will be understood, however, that the 16 threads shown would occupy a very narrow width in general, and that in practice all the 8 holes in each short row of the comberboard are in a line parallel to the edge of the board, and not at an angle as

illustrated. Hence, when the jacquard harness is tied up from the lingoes to the hooks, say of the jacquard in Fig. 1, the warp threads could be drawn through the mails of the harness either backward or forward as demonstrated in Fig. 3. It will be seen later, however, that the two distinct orders of drawing-in the threads involve different methods of cutting the cards and of reading the horizontal lines of the point-paper design.

As already mentioned, each 400's jacquard machine contains 51 short rows of needles and hooks, 8 of each kind in each short row. The heads of the 408 hooks form a rectangle with an area of about 13½ in. by 7 in. The general arrangement of the needles, hooks, needle board, spring box, hook-rest and hook-rest support are illustrated in perspective in the lower part of Fig. 4, while the upper illustration, marked A, represents the hook-rest, and indicates the relative lengths of the long sides and short sides of the above-mentioned rectangle. If the needle board in Fig. 4 were situated over the cloth and the weaver's head, the position of the jacquard would be identical with that illustrated in Fig. 2.

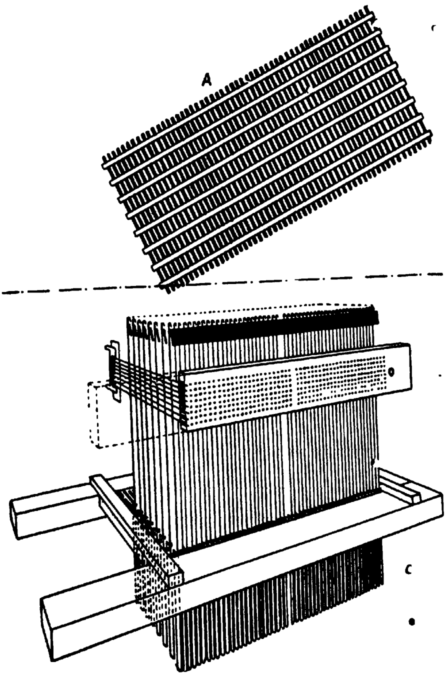


FIG. 4.

The views in Figs. 1 and 2 indicate, as just stated, the same jacquard viewed from the two ends of the same loom. They may, however, represent two different positions of the jacquard with respect to the front of the loom. Thus, if the needle board and the cylinder were situated over the cloth and the weaver's head, as in Fig. 43, and the loom in Fig. 2 viewed from the reader's position, the front of the loom and the position of the weaver is represented by the letter W. In this case, the numbers of the needles, hooks, and cords nearest the reader would be as marked, *i.e.* 401 and 408; but the first row of needles, hooks, and

cords, Nos. 1 to 8, would clearly be at the other end of the loom. Consequently, the views in Figs. 1 and 2 may, when desired, be taken to represent two different jacquards on two adjoining looms in which the jacquard cylinder is on the left-hand side in Fig. 1, and on the right-hand side in Fig. 2. Hence, since the letter W represents the position of the weaver with respect to the front of the loom, it is clear that with the arrangement indicated in Fig. 1, the jacquard cards would hang over the warp beam, whereas with the parts in the positions shown in Fig. 2, the jacquard cards would hang over the weaver's head and the cloth. Both arrangements are adopted in practice, wherever it is possible, for the sake of economising floor space. In both cases, the long sides of the comberboard are parallel to the long sides of the cylinder and jacquard.

It is impossible to alter the positions of the comberboard, or the equivalent harness-reed, in the loom, but, on the other hand, it is possible to alter the position of the jacquard with respect to the comberboard. The jacquard may, for example, be turned one-quarter round from the position indicated in Fig. 1 or Fig. 2. This change would obviously place the long sides of the cylinder and the jacquard parallel to the ends or short sides of the comberboard, in which case the cards would hang at or near one end of the loom.

CHAPTER II

THE JACQUARD HARNESS: STRAIGHT-THROUGH, REPEATING, AND CENTRE TIES

SINCE there are two distinct ways of arranging the jacquard in relation to the comberboard, there will be two general and distinct dispositions of the harness cords which bridge the gap between the comberboard and the bottom bends of the hooks or uprights. These two distinct dispositions are known by the terms:

1. Norwich or Straight Tie.
2. London or Crossed Tie.

When the card cylinder and the needle board (the long sides of the jacquard) are parallel to the long sides of the comberboard, the harness tie for any kind of pattern is termed the "Norwich Tie" or the "Straight Tie," but when the card cylinder and the needle board are at right angles to the long sides of the comberboard, the harness tie for any kind of pattern is termed the "London Tie" or the "Crossed Tie."

A little consideration will show that there are, in reality, four different positions that any jacquard machine may occupy with respect to a comberboard. For instance, the cylinder may be at the back of the loom, at the front of the loom, on the left-hand side or on the right-hand side. It is essential that those who have charge of the card-cutting department should know the effect which any of these positions will have upon the design on the woven fabric. This phase of the question is, indeed, a very important one, and it is dealt with more fully at a later stage of this work (see pp. 219 to 234, Chapter XII.).

The particular ways in which the harness cords are "tied" or "mounted" to the hooks, irrespective of the position of the jacquard machine, are defined by special names—"harness ties." Such names result in general from the type of ornament which has to be developed on the surface of the cloth. Thus, there are the following:

1. Straight-through Tie: this title is given when there is no repetition of the pattern between the selvages of the cloth, *i.e.* when there is one unit only of the design in the width.

2. Repeating Tie: this term is used when there are two or more repetitions of the same pattern in the width of the cloth.
3. Centre or Pointed Tie (also termed the "lay-over tie"): this tie is suitable only for symmetrical patterns.
4. Mixed Ties or Compound Ties: these ties involve the use of two or all of the foregoing ties.

We shall illustrate in different ways all the above-mentioned four types, and, in addition, we shall supply other particulars concerning the general relation between the various parts involved.

All jacquards control the threads of the warp, when the latter are rising and falling, through the medium of a series of cords which connect the lower ends of the jacquard hooks with the glass, brass, or other similar metal mails through which the warp threads are drawn. Each cord may consist of two or more distinct parts—viz., neckband or tailcord, long cord or harness cord, and the prepared lingoe; but at present we shall assume that the constituent parts of the connection between the jacquard hook and the mail are one cord, to which is applied the general name, "harness cord." In some extreme cases each jacquard hook carries only one such cord, and controls only one thread of the warp; hence the total number of threads in the warp, excluding selvage threads, must be the same as the number of hooks in the jacquard. In order, however, to produce fabrics of suitable and various widths, it is customary for reasons of economy to arrange that each jacquard hook shall carry two or more such harness cords, and thus control two or more threads of the warp at different points in the width of the fabric, the said points being predetermined in accordance with the type of pattern to be produced. By this means practically any desired width of fabric may be produced with a reasonable number of needles and hooks.

The system or method by which these harness cords are arranged in their respective positions in the comberboard or in the harness reed is termed the "harness tie," or "harness mount." Owing to the very extensive range of jacquard-figured textiles there is an infinite number of ways in which any complete group of harness cords may be arranged to form a tie, but the differences are more in detail than in principle, and all harness ties may be classed in one or other of the above-mentioned four groups. In the machine illustrated in Fig. 4, the cylinder is not shown, and the end of the needle board is shown cut off flush with the last row of needles and hooks (the first row being on the right hand when facing the cylinder or needle board), but otherwise the illustration provides a fair idea of the relative positions of the component parts of the machine. It would, however, be clearly unwise to attempt to show in true perspective, and from the same position as that indicated in Fig. 4, all the connections from the bottom of the hooks to the warp threads. At the best we could show

distinctly hooks from only one short row or one long row of the machine. When the object is to show harness ties in which both of these rows appear, we may show them as if viewed from a similar position, but instead of attempting to illustrate them in pure perspective we shall adopt some modified form so as to display the necessary parts to advantage. When the height of the eye is between the comberboard and the jacquard machine—the normal position—the underside of the machine is exposed to view, and the position of any particular hook, with its connections to the comberboard, through the medium of the harness cords, may be plainly seen.

The repeating tie, often called the all-over repeating tie, is of the simplest kind; it really embraces all ties in which the threads of the warp are drawn through the mails of the harness in regular succession from the back of the comberboard to the front, or *vice versa*, as exemplified in Fig. 3. This system corresponds in a sense to the straight drafts in shaft work, but the total number of hooks used in harness work corresponds to the number of shafts used for tappet or dobby work; the number of long rows in the comberboard must not be confused with the same number of shafts. As has already been mentioned, there may be only one complete unit of the draft in the harness—no repetition; and this, the very simplest type of harness tie, the straight-through tie, is illustrated in Fig. 5. It is also termed "the all-single tie," although it is precisely of the same type as repeating ties. The machine is a 400's jacquard of the English type, where a wooden or iron bottom grate A, with the necessary transverse rods, forms the support of the hooks when the latter are in their lowest position, and in this particular illustration there is no gap between the 26th and 27th short rows of hooks; in practice a gap is left, as will be seen later, to provide room for the centre lacing of the cards. The cylinder in Fig. 5 is at the back of the loom, hence the first or leading thread is at the weaver's left hand and at the back of the comberboard. The first eight threads of the warp are operated by the first short row of cords, which are shown as being attached to the second row of hooks in the machine, 9th to 16th inclusive. The first row of hooks has been purposely omitted, as indicated by the eight unfilled holes at the left-hand side of the bottom board A, because this row is almost invariably left for special work when one jacquard only is in use. A neckband B is attached to the lower end of each hook D, and a single harness cord C is tied to each neckband B, and then shown as passing through a hole in the comberboard E. Further connections are considered unnecessary at this stage, the object being to show the distribution of the harness cords for pattern purposes only. No selvage cords are included, although these would naturally be required for the fabric; the corresponding selvage threads at each side of the texture would be controlled in this case by the same hooks, and all the selvage hooks would be in the

first row of the machine, unless special hooks and needles are provided in addition to the normal complement of the machine. The wires for the heck

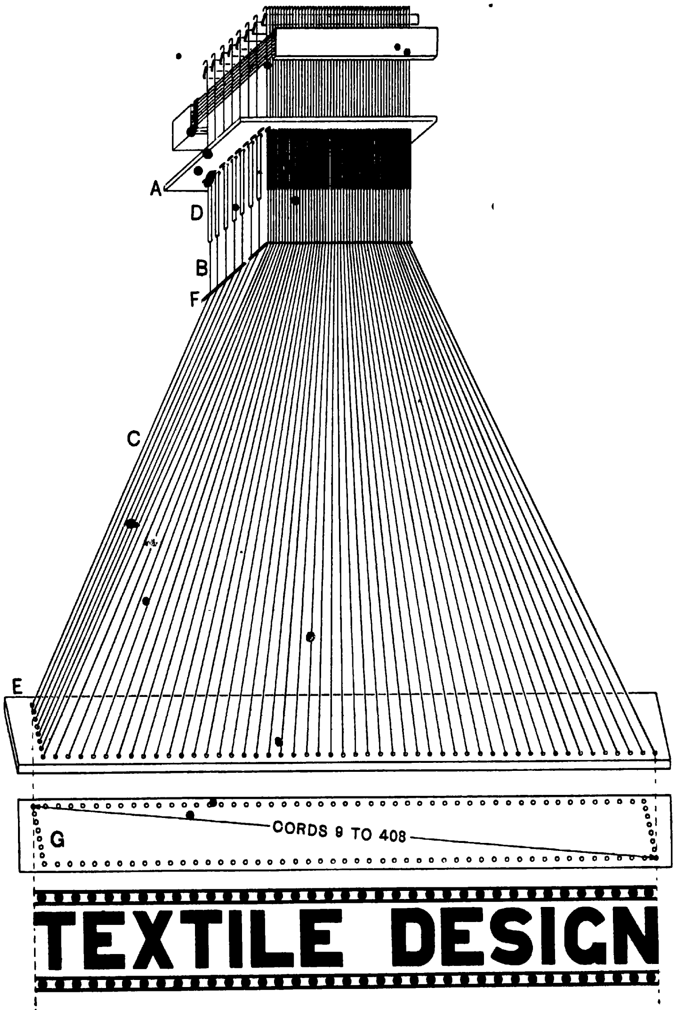


FIG. 5.

are shown at F, the purpose of which is to secure a uniform lift of the threads from selvage to selvage.

A plan of the comberboard appears at G, and it will be seen that there are in all 400 cords (9 to 408 inclusive), while immediately under the plan we have introduced a simple design, composed mostly of letters, to show that there is no repetition of the pattern at any point of the design if we except the repetition of the letters T, E, and I. The dotted lines from the first and the last hooks show clearly that 400 different threads are required to reproduce the design. Now, in actual work 400 threads would form only a very narrow fabric, unless in a coarse set; but nevertheless this figure

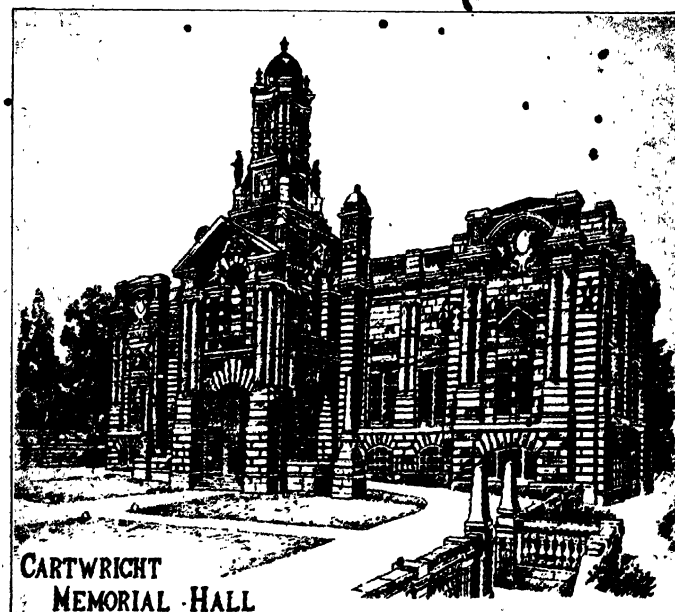


FIG. 6.

illustrates not only the method and tie adopted for narrow ribbons or bands of simple design in various kinds of fabrics, but also the harness tie adopted for the most elaborate silk designs as woven for banners and similar articles, where every thread is worked independently of any other. It would probably be impossible to develop the words "Textile Design" with such a small number of hooks. The principle, however, would be the same if a machine with 1200 needles and hooks were used.

If the words "Textile Design" were to be woven in a narrow fabric in the vertical direction instead of the horizontal, perhaps not more than 70

to 100 threads would be required (and consequently a jacquard of 100 hooks capacity would be sufficient). It is a common practice in the weaving of certain fabrics to adopt this method of developing the ornament since a minimum number of needles and hooks is required. Thus, the reproduction of the woven silk picture illustrated in Fig. 6 shows that the height of the pattern is much less than the width. The figure is a representation of the Cartwright Memorial Hall in Manningham Park, Bradford. During the weaving process the cloth appeared 90 degrees farther round, and even then the narrower width required 1200 needles and 1200 hooks for the work, with a straight-through tie. If the cloth had been woven in the position represented in Fig. 6, *i.e.* with the warp threads for the width, it would have been necessary to employ 1728 needles and 1728 hooks.

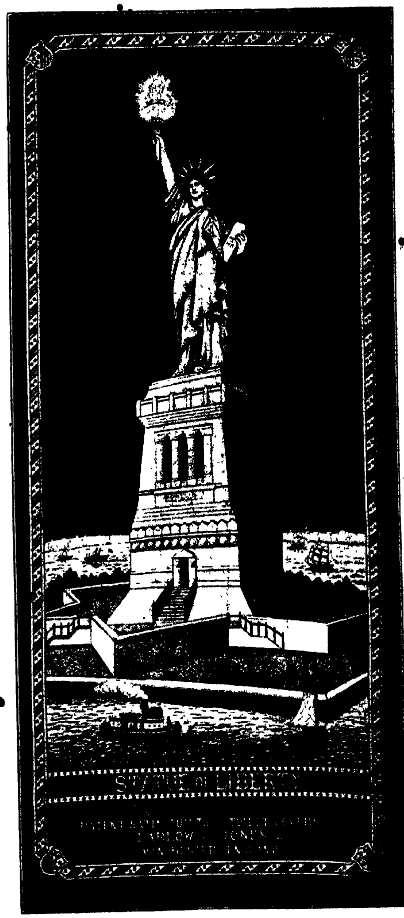


Fig 7.

Fig. 7 is a photographical reproduction of a unique patent quilt fabric, 19 in. wide by 39 in. long, made by Messrs. Barlow and Jones, Ltd., Manchester, the sole makers of the well-known "Osman" cloths. A glance at this figure shows at once that the ornament on the cloth was developed by means of the "straight-through tie-up"; moreover, it was woven with the warp threads parallel to the length of the cloth. Four jacquard machines (two of 612 needles and two of 312 needles) were utilised for the work, and yet, as already stated, the tie-up contained only one unit. Altogether 22,600 individual jacquard cards were used, 5650 for each

machine, and since each row of four cards served for two picks, the cloth contains 11,300 shots of weft.

For certain elaborate designs of the straight-through character there may be thousands of independent threads, involving the use of as many individual hooks and needles in one or more jacquards. An interesting silk picture was made several years ago (the early part of this century) by means of 6 jacquard machines, each with 1312 needles, or 7872 needles in all, and 43,776 cards. The harness tie for this remarkable picture was on the straight-through principle.

Of all the so-called repeating ties the one just described and illustrated is used least, if we except narrow wares. Even if 400 threads are required for one unit of the design, it generally happens that two or more of these units are required to make up the given width. Whatever number of repeats is required, however, the same principle is observed in the harness tie. Thus, suppose that it were desired to reproduce the simple repeating design in Fig. 8 in each of the parts marked:

FIRST REPEAT. SECOND REPEAT. THIRD REPEAT.

It is evident that in the portion marked "First Repeat," which is the unit design in the width (about $1\frac{1}{2}$ repeats of the unit appear in the way of the weft), there could be formed no two vertical divisions, however narrow, which would be identically the same. Therefore, whatever number of harness cords and threads are used to reproduce this unit pattern, each one must be operated by its own needle and hook. In practice, the pattern may be developed on almost any number of threads, large or small, provided that the minimum number used is sufficiently great to develop every detail in the design in the desired width; but to demonstrate the principle upon which the harness tie for this pattern is based, we shall assume that every row of a 400's jacquard (all the 408 needles and hooks) are to be utilised for the production of the ornament, and that the selvages and other narrow strips outside the pattern proper are to be obtained by parts not yet described. It will thus be seen that it is intended to utilise 408 needles and hooks for the reproduction of the ornament represented in Fig. 8 above the words "First Repeat." Now both the second and third repeats in this figure are identical from point to point with the first repeat, so that the 408 hooks, which control the 408 harness cords C (see Fig. 5) and the 408 threads for the first repeat in Fig. 8 may also be utilised to control the corresponding threads of the warp in the second and third repeats, or indeed, of any higher number of repeats, if a greater width of cloth is required in the same sett or porter.

To accomplish this, it will obviously be necessary to have 408 × 3 repeats = 1224 threads controlled by 1224 distinct mails and harness cords; hence,

each of the 408 hooks must actuate three harness cords and three threads of the warp (one in each repeat of the pattern in Fig. 8). These three threads, one in each section, must naturally rise and fall in unison with the hook; consequently the three corresponding harness cords must be attached to the hook or rather to the neckband B, Fig. 5, which depends from the hook.

The manner in which this extension or duplication of the pattern is obtained is illustrated in Fig. 9. In this view the hooks D are typical of those used in Scottish jacquards in which the bends on the hooks rest, when in their lowest position, on the rods H; in this machine, the rods H serve the same purpose as the hook-rests on board A, Fig. 5.

If the three harness cords from the bottom of No. 1 neckband B, Fig. 9, be followed from the knot marked C^1, it will be found that each separate

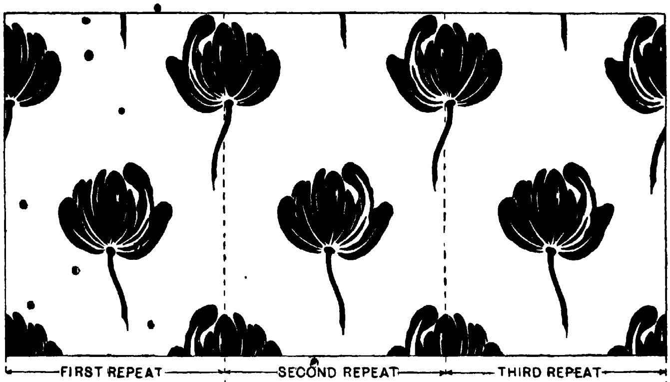


FIG. 8.

cord C passes to the back of the comberboard E, and that each individual cord passes through the back hole in the corresponding short rows, and therefore occupies the first position in its respective section or repeat. Numbers 2, 3 . . . 8 follow in regular succession until the front hole in the comberboard is reached. It is unnecessary, and indeed impracticable, to draw all the cords; as a matter of fact not a single cord need be drawn to indicate the nature of the tie-up. All this information can be exhibited by drawing a simple rectangular figure as at E^1 to represent the comberboard, and to mark in clearly the first and last short rows, or even only the first and last holes, and to join the latter as exemplified. Thus, in each of the repeats in the diagram E^1 an arrow joins the back hole in the first short row to the front hole in the last short row, and the direction pointed by the arrow indicates, as it were, the draft. In the present instance, the drafts of all three repeats or sections are from back to front.

The general arrangement of the parts in Fig. 9 shows that the tie is a

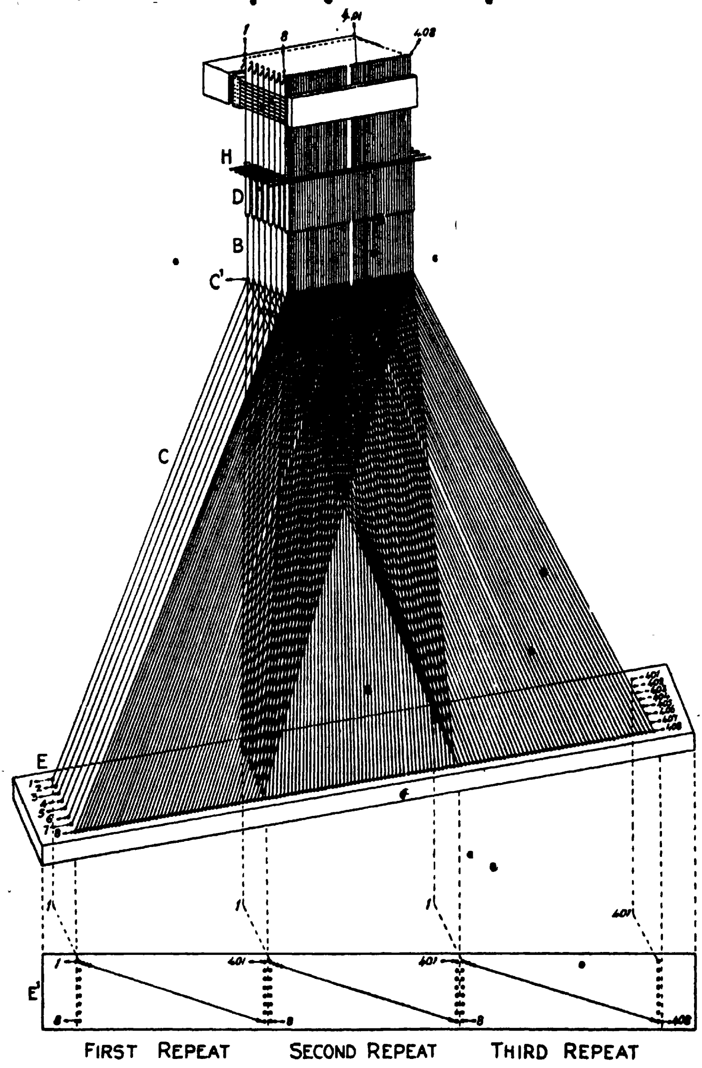


FIG. 9.

"Repeating Tie," and that it is arranged on the Norwich or Straight system, and so is that in Fig. 5. If the position of the weaver is represented

by that of the reader, the cards would be situated over the warp. If the cards were intended to hang above the weaver, the jacquard would be turned through 180 degrees. The hooks are numbered as well as the comberboard, while the connection between the hooks and the needles is clearly illustrated. The gap left for the centre lacing is shown quite plainly in this figure.

The machine in the foreground of Fig. 10 is a 400's double-lift, single cylinder jacquard; the harness is tied up on the Norwich principle for three repeats or units of the pattern in the width of the cloth; in this particular case the units are in different colours as shown by the woven cloth. The harness cords and the comberboard are clearly seen. The loom behind is a single-lift 25-row twilling jacquard, and in both cases the cards hang over the warp. The looms are driven electrically by small individual motors supported by the stands on the left.

If, before the mounting of the harness took place, the jacquard were turned through 90 degrees, then the mounting for the design shown in Fig. 8 would be as exemplified in Fig. 11. In this illustration, the cylinder of the jacquard has been omitted, but the needle board J is shown, as well as the spring box S, the hook-rest board A, and a bottom board K. All the hooks of one long row and the hooks of one short row are shown, as well as the needles for the latter, and again the full 408 needles and hooks have been utilised, but the tie-up is shown only to a few short rows of the comberboard. No. 1 hook is identical with that in Fig. 9, but it occupies a different position with respect to the comberboard.

As in Fig. 9, the three cords from hook No. 1 in Fig. 11, and shown in heavy lines, pass to the back holes of the first short rows in the three sections or repeats, and, in each case thereafter, the cords in regular succession occupy the holes 2, 3, 4, 5, 6, 7 and finally 8, the latter being in the front row of the comberboard. Similar heavy lines indicate the connection between the last short row of the jacquards (hooks 401 to 408 inclusive) and the three corresponding short rows in the comberboard E. In addition, a series of light lines are drawn from the middle short row (the 26th) of hooks in the jacquard to the middle short row of each section or repeat in the comberboard. The various parts are numbered in order that the tie-up may be easily followed.

In Figs. 5, 9 and 11, the comberboard is shown as a solid block, and no provision is illustrated for fastening it in its correct position; slots near the ends of the board or else in its supports are provided for this purpose. Instead of a solid block comberboard, thin sectional strips, similar to the illustration at L, in the lower part of Fig. 11, are often used. When these strips are closed together, they serve the same purpose as a solid board, and they possess advantages over the solid board which shall be discussed in

FIG. 10.

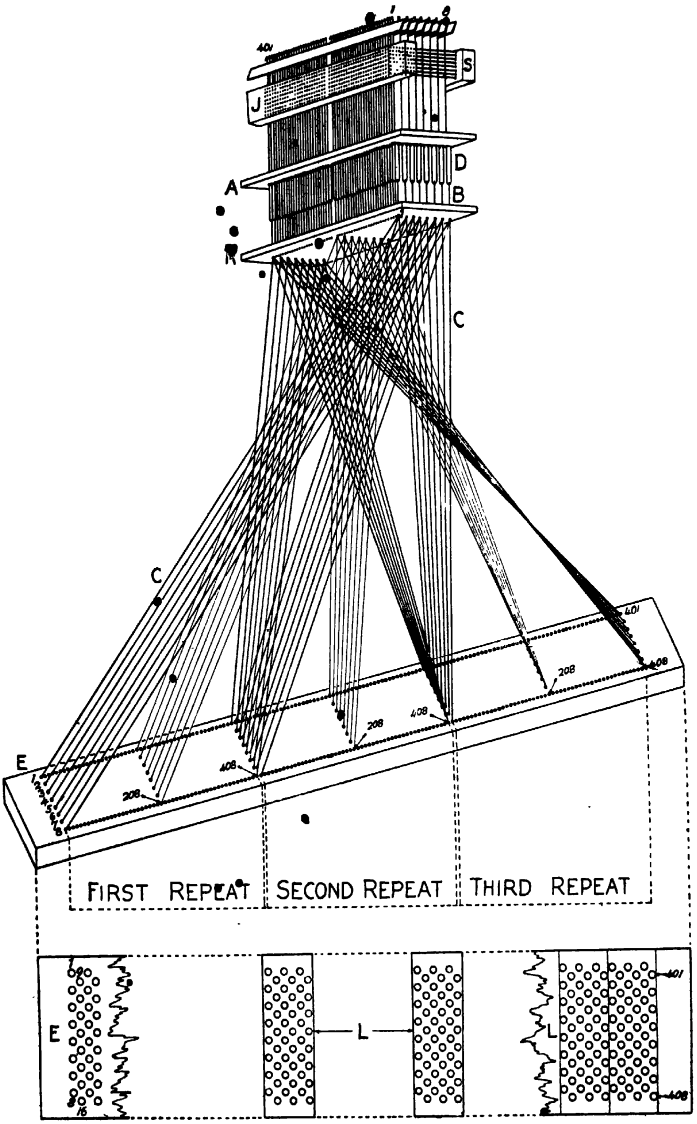


FIG. 11.

C

the proper place. These slips have specially prepared frames to support them, and the frame is fixed in a similar manner to that employed for solid boards. Two slips are shown in position on the extreme right in the lower diagram in Fig. 11. All the parts in this lower diagram are drawn to a much larger scale than the remaining parts of the figure, and, in practically all cases, the holes are staggered or zigzagged as shown.

The method of mounting or tying-up illustrated in Figs. 5 and 9 has many advantages over that illustrated in Fig. 11, *inter alia*, the simplicity of mounting, and the introduction of the minimum amount of friction amongst the harness cords.

It has, however, the disadvantage of fixing No. 1 hook, or the leading harness cord, at the weaver's left hand or at the right hand, according as the cards fall over the warp or over the weaver's head respectively. With the London tie, Fig. 11, on the other hand—*i.e.* where the long rows of the jacquard are at right angles to the long rows of the comberboard—the leading harness cord, and therefore the leading thread of the warp, may be arranged when tying up the harness, either at the weaver's left hand or at her right hand as desired, independently of whether the cards fall to her right or to her left. A number of looms with the jacquards arranged for the London tie are illustrated in Fig. 12.

In Fig. 11, and as already pointed out, No. 1 hook is connected to a harness cord which passes to the weaver's left and through a hole in the back row of the comberboard. Similarly, the two other cords attached to No. 1 hook pass to holes in the back row. But little consideration is required to see that these cords might have been equally well passed to the weaver's right hand, and to holes in the front row of the board at present numbered 408. In like manner cords from hook No. 8 would have been taken to the right and to the back row instead of to the left and to the front row as illustrated. In this way the leading cord of the harness would have controlled threads to the right hand of the weaver, and succeeding threads would have followed from right to left.

In many cases it is immaterial as to whether a pattern is developed from left to right, or *vice versa*, but in other cases it is essential that this point should receive consideration. The London tie has the advantage that by means of it a jacquard can be tied up to read either from left to right or from right to left, no matter at which hand of the weaver it is necessary that the cards should fall.

Where jacquards are extensively used for the production of all-over or repeating patterns of the type indicated—*e.g.* in the production of dress goods and similar fabrics where the size of the pattern is comparatively small, and where a large number of different weaves are used (not necessarily for the same fabric, but in the same loom for different fabrics)—it is

very common practice to leave out of action a certain number of the hooks

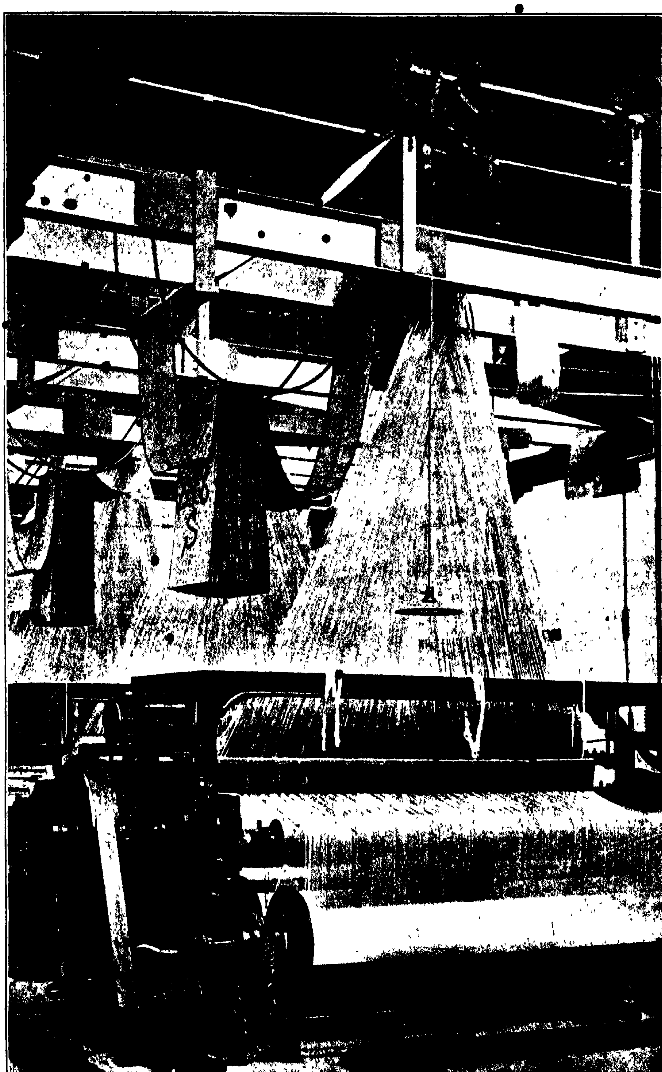


FIG. 12.

n order that a fabric having a different number of threads per inch may be

woven by the machine. Take, for example, the jacquards in common use in Bradford and other districts where similar goods are manufactured; these machines usually contain 304 needles—a number which is found to be ample for the weaving of the majority of such fabrics—and they are often tied up so that the working capacity of the machine, or the number of needles in use, is suitable for a comparatively large number of ground weaves. For this reason the straight repeating ties are seldom mounted in multiples of ten, but generally in multiples of eight or twelve. Leaving aside the character of the design for the time being, it is quite evident that most of the useful small weaves are on 2, 3, 4, 5, 6, and 8 threads; and of these weaves those on 5 threads, excepting those for damasks, are perhaps the least employed. It is therefore not surprising to find that the above machines are often tied up to be suitable for weaving fabrics, the grounds of which may be developed in 2, 3, 4, 6, 8 or 12 thread weaves. Such being the case, it is evident that a tie-up of 288 hooks is, on the whole, the most useful one; while for similar reasons 200's and 400's machines are often tied up to 192 and 384 hooks respectively when intended for the same type of goods. The 384 tie-up is exceedingly useful for these fabrics and for experimental weaving, since all weaves on 2, 3, 4, 6, 8, 12, 16, 24, 32, 48, 64, 96, 192, and 384 threads may be woven without any break between the various repeats.

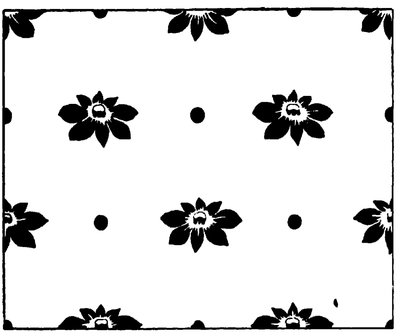


FIG. 13.

The absolute necessity for the number of hooks employed being a multiple of the unit weave depends, however, upon the character of the design. If the figures in the design are detached as illustrated in Fig. 13, then it is essential that the ground weave unit should be a measure of the number of needles and hooks in use. It is easy to see that this is the case, for the ground weave must be continuous from side to side, as well as from bottom to top of the design, otherwise a break in the pattern would clearly obtain in each repeat. If, however, the main figures in Fig. 13 be surrounded by any kind of continuous ornament—*e.g.* ribbon work, diagonal lines in both directions or only in one direction, ogee forms, or, say, circles as illustrated in Fig. 14—then the conditions are entirely different. It is obvious that in such cases each enclosed area formed by the interlacing or encircling ornament may be treated as an isolated section, and conse-

quently the number of hooks need not necessarily be a multiple of the unit weave. Moreover, with such a design, it is evident that different ground weaves may be used in the various sections without in any way impairing the beauty of the design or the woven fabric; indeed, in many cases such a recourse may have the opposite effect, and may greatly enhance the value of the textile product. Nevertheless, it is always a distinct advantage to have the machine tied up so that it is suitable for the majority of useful weaves, because it is quite clear that such an arrangement is equally adapted for the groundwork of detached or enclosed figures.

The number of threads or harness cords per inch in the comberboard or harness reed depends partly upon the kind of fibre used, partly upon the structure of the cloth, and partly upon the weaves used and the effect desired in the fabric. Theoretically any number per inch may be used, and the machine tied up for this number; but when once tied up for any particular number, that number is fixed within very slight limits for all patterns in which all the hooks and needles of the tie-up are in operation. In other words, the sett of the fabric is fixed unless some of the needles and hooks remain inoperative. To illustrate this point clearly let us take a concrete case, say, of a 300's machine tied up with 288 hooks per repeat and mounted for a 27 in. cloth with 96 threads per inch in the reed.

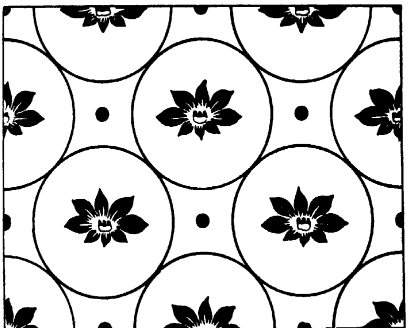


FIG. 14.

$$\frac{288 \text{ hooks}}{96 \text{ per inch}} = 3 \text{ in. of cloth in each repeat of the pattern,}$$

and $$\frac{27 \text{ in. width}}{3 \text{ in. pattern}} = 9 \text{ repeats of pattern in the cloth;}$$

or $$\frac{96 \text{ threads per inch} \times 27 \text{ in. wide}}{288 \text{ hooks}} = 9 \text{ repeats of pattern in 27 in.}$$

Consequently for this mounting each hook of the jacquard would require to be furnished with nine harness cords, one cord for each repeat of the pattern, and the tie-up would be a repeating one similar to Fig. 9 or Fig. 10.

So long as the cloth requires to have 96 threads per inch, the above conditions would remain intact, and the full complement of tied-up hooks

would be used; but if a similar fabric were required to contain a different number of threads per inch, then it is obvious that some alteration would be necessary. It is clearly impossible to make a cloth with more threads per inch without re-tying the harness to suit, but cloths with fewer threads per inch may be, and often are, woven in such a loom. Any such reduction of sett, however, must be accompanied by a reduction in the number of hooks in use, and those hooks or cords which for the time being remain inoperative are said to be "cast out," or "fileyed.". Since the number of complete rows cast out in the harness is proportional to the sett or porter of the fabric, the width of the fabric for the reduced sett will be the same as that of the original. Thus, 36 rows of 8 hooks per row give a 3 in. pattern on 96 threads per inch; therefore 35 rows would give

$$\frac{96 \text{ threads} \times 35 \text{ rows}}{36 \text{ rows}} = 93\tfrac{1}{3} \text{ threads per inch.}$$

This shows the method of finding the resulting sett from any reduction in the number of rows per repeat, but it does not follow that every reduction will prove satisfactory. For instance, in the above case one row cast out in 36 means that there are 35 rows of hooks and needles to be used—that is, the hooks and needles in actual work are to be reduced from 288 to 280. Now this particular reduction gives a number which, unfortunately, reduces the general value of the tie, since weaves repeating on 3, 6, 9, 12, etc., cannot be used except for patterns similar in nature to that in Fig. 14. Besides, a reduction in sett from 96 per inch to $93\frac{1}{3}$ per inch is scarcely perceptible in the cloth, and therefore such a reduction in this sett would be rarely attempted.

The first satisfactory reduction in the above-mentioned tie-up is obtained by leaving three idle rows in the machine in addition to those already left out—that is, leaving idle three rows or twenty-four hooks per repeat, thus reducing the number in the repeat from 288 to 264, and making the sett equal to

$$\frac{264}{3} = 88 \text{ threads per inch.}$$

Similar satisfactory reductions may be made by casting out additional groups in multiples of 3 rows or 24 hooks at a time, thus reducing the sett each time by 8 threads per inch. By proceeding in this manner the total number of hooks still left in the repeat will be some multiple of 24, and will therefore be satisfactory for any weave which repeats on 2, 3, 4, 6, 8, 12, or 24 threads. Casting out by such a method, if practised systematically, may be made to give a 3 in. pattern in any of the seven setts in Table I.:

TABLE I

—	1	2	3	4	5	6	7
Threads per inch	96	88	80	72	64	56	48
Width of pattern	3 in.	3 in.	3 in.	3 in.	3 in.	3 in.	3 in.
Threads per repeat	288	264	240	216	192	168	144
No. of rows employed	36	33	30	27	24	21	18
	1	1	1	1	1	1	1
	2	2	2	2	2	2	—
	3	3	3	3	—	—	3
	4	4	4	4	4	4	—
	5	5	5	5	5	5	5
	6	6	—	—	—	—	—
	7	7	7	7	7	7	7
	8	8	8	8	8	—	—
	9	9	9	—	—	9	9
	10	10	10	10	10	—	—
	11	11	11	11	11	11	11
	12	—	—	—	—	—	—
	13	13	13	13	13	13	13
	14	14	14	14	14	14	—
	15	15	15	15	—	—	15
	16	16	16	16	16	16	—
Rows of jacquard in use. Dashes (—) represent rows cast out.	17	17	17	17	17	17	17
	18	18	—	—	—	—	—
	19	19	19	19	19	19	19
	20	20	20	20	20	—	—
	21	21	21	—	—	21	21
	22	22	22	22	22	—	—
	23	23	23	23	23	23	23
	24	—	—	—	—	—	—
	25	25	25	25	25	25	25
	26	26	26	26	26	26	—
	27	27	27	27	—	—	27
	28	28	28	28	28	28	—
	29	29	29	29	29	29	29
	30	30	—	—	—	—	—
	31	31	31	31	31	31	31
	32	32	32	32	32	—	—
	33	33	33	—	—	33	33
	34	34	34	34	34	—	—
	35	35	35	35	35	35	35
	36	—	—	—	—	—	—

Further reductions might be made, but they would be warranted only in extreme cases, since any greater reduction than that shown in the last column would clearly necessitate the casting out of two consecutive rows of hooks—a most undesirable expedient. For the coarser setts it would be much more satisfactory to tie up the harness, say, for a maximum of 64 threads per inch on 24 rows, or 192 hooks, of a 200's jacquard, for it must be remembered that however few rows are cast out, the card used is

theoretically in all cases, and practically in some cases, greater than what is actually required for the reduced number of needles in use.

If 192 hooks of a 200's jacquard be tied up for 64 threads per inch, the principle of reduction just described may obtain, as shown in Table II.

TABLE II

—	1	2	3	4	5
Threads per inch	64	56	48	40	32
Width of pattern	3 in.	3 in.	3 in.	3 in.	3 in.
Threads per repeat	192	168	144	120	96
No. of rows employed	24	21	18	15	12
Rows of jacquard in use. Dashes (—) = cast out rows.	1	1	1	1	1
	2	2	2	2	—
	3	3	3	3	3
	4	4	—	—	—
	5	5	5	5	5
	6	6	6	—	—
	7	7	7	7	7
	8	—	—	—	—
	9	9	9	9	9
	10	10	10	10	—
	11	11	11	11	11
	12	12	—	—	—
	13	13	13	13	13
	14	14	14	—	—
	15	15	15	15	15
	16	—	—	—	—
	17	17	17	17	17
	18	18	18	18	—
	19	19	19	19	19
	20	20	—	—	—
	21	21	21	21	21
	22	22	22	—	—
	23	23	23	23	23
	24	—	—	—	—

Should this arrangement not prove sufficiently flexible, or permit of a sufficiently fine gradation of setts—a drop of 8 threads per inch in the lower grades is perhaps too much—reduction may be made by casting out single rows of 8 at a time on a similar system, although this system would necessarily, in certain cases, prevent the use of some ground weaves. For example, suppose 192 hooks of a 200's jacquard were tied up with 72 threads per inch, the pattern would clearly be

$$\frac{192 \text{ hooks}}{72 \text{ threads}} = 2\tfrac{2}{3} \text{ in. wide};$$

but by casting out one row of 8 hooks for each decrease in the sett, a differ-

ence of 3 threads only would obtain between successive setts. The following Table III. shows this, but weaves on 3, 6, 9, or 12 threads cannot be used with those setts marked with an asterisk.

TABLE III

—	1	2	3	4	5	6	7	8	9
Threads per inch .	72	69*	66*	63	60*	57*	54	51*	48*
Width of pattern .	2⅔ in.	2⅔ in.	2⅔ in.	2⅔ in.	2⅔ in.	2⅔ in.	2⅔ in.	2⅔ in.	2⅔ in.
Threads per repeat .	192	184	176	168	160	152	144	136	128
No. of rows employed.	24	23	22	21	20	19	18	17	16
	1	1	1	1	1	1	1	1	1
	2	2	2	2	2	2	2	2	2
	3	3	3	3	3	—	—	—	—
	4	4	4	4	4	4	4	4	4
	5	5	5	5	5	5	5	5	5
	6	6	6	—	—	—	—	—	—
	7	7	7	7	7	7	7	7	7
	8	8	8	8	8	8	8	8	8
	9	9	9	9	9	9	9	—	—
	10	10	10	10	10	10	10	10	10
Rows of jacquard in	11	11	11	11	11	11	11	11	11
use.	12	12	—	—	—	—	—	—	—
Dashes (—) = rows	13	13	13	13	13	13	13	13	13
cast out.	14	14	14	14	14	14	14	14	14
	15	15	15	15	15	15	15	15	—
	16	16	16	16	16	16	16	16	16
	17	17	17	17	17	17	17	17	17
	18	18	18	18	—	—	—	—	—
	19	19	19	19	19	19	19	19	19
	20	20	20	20	20	20	20	20	20
	21	21	21	21	21	21	—	—	—
	22	22	22	22	22	22	22	22	22
	23	23	23	23	23	23	23	23	23
	24	—	—	—	—	—	—	—	—

These methods of casting out present no difficulty with regard to the painting of the design. The design is enlarged or transferred to point-paper on the requisite number of blocks, but the card-cutter must be instructed with regard to the number and the positions of the rows which are to be idle, so that whenever he comes to one of these numbers he may give a blank tread. The pegs, corresponding to the missed rows, may be withdrawn from the piano rack ; or separate milled racks, with teeth omitted at the desired places, may be provided for the different orders of casting out. The ordinary index card on the piano would then be dispensed with, and special arrangements made for facilitating the reading of the design ; if the ordinary index card is used, the design would probably be cut into

strips at those points where the rows are cast out, and unpainted blocks of design-paper inserted, so that no cutting could take place on blank rows.

In certain cases there appear at first sight to be simpler methods of casting out than those mentioned. For example, where one-eighth or one-quarter of the harness is to be dropped in a 300's or 400's machine, it would seem simpler to drop one long row or two long rows respectively. The objection to this system would be the fact that the design-paper would have to contain 6 or 7 rows of small squares between each pair of vertical heavy lines, and the weave in most cases would be more difficult to insert on such paper. If suitably ruled paper could not be obtained, then special hand ruling in 6's or 7's in a distinctive colour of ink would be necessary. It also appears simpler to leave all the idle hooks at the two ends of the machine, thus simplifying card-cutting; but this method naturally leaves large groups of unoccupied mails after each repeat, and the space occupied by these groups causes the threads near the beginning and finish of each repeat " to draw " on account of their path not being perfectly perpendicular or square to the reed. Several rows, at any particular part, say at one or both ends, may be omitted when re-tying is necessary. This method, however, is a little outside the present discussion.

Harness Ties for Striped Designs.—These may be divided into two general classes, thus:

1. Those in which the whole of the warp is controlled by the joint action of the jacquard or jacquards and the harness.

2. Those in which a number of the stripes, often alternate ones, are controlled by the jacquard and harness, and the remainder of the stripes controlled by shafts or healds.

The breadth of the stripes may, of course, be broad or narrow, depending upon the sett, the extent of the design, the use to which the fabric has to be put, and upon the capacity of the jacquard.

The great majority of the designs intended to come under Class 1 are of such a nature that, although they are termed, and actually are, striped designs, the tie-ups are subject to exactly the same conditions as those for many designs in which the ornament has no resemblance whatever to a stripe nature. In such cases, the tie-ups shown in Figs. 5, 9, and 11 would meet the requirements.

Consider, for example, Fig. 15; the single unit or repeat of the design is, obviously, of a very pronounced stripe character, since it consists of:

(*a*) A black figure on a white ground, alternating with

(*b*) A white figure on a black ground.

These sections, fully worked out, are marked respectively L and D, and the repeats, two of each, would appear in the blank rectangles to the right; these are distinguished by the same letters L and D. The positions which

their controlling harness cords C would occupy, are also indicated by the same letters on the comberboard E, where the staggered holes represent the first and last short rows in each section as well as the front staggered row. This latter row could, of course, represent cords from No. 9 needle and hook and all others in the corresponding long row, or No. 16 needle and hook with the full complement in the same long row, depending upon the method of drawing-in the harness, see Fig. 3. (The first short row and last short row have been omitted in Fig. 15 as stated.)

The comberboard E is shown arranged for three complete repeats to correspond with the three repeats (six sections) occupied by the design and its adjoining places of repetition below the comberboard E. A small strip is shown near each selvage, but no cords are shown descending to them; cords would be necessary at these places, however, in order that the woven texture would exhibit an unbroken curved outline at the edges of the design.

In Fig. 15 we have purposely omitted the jacquard itself, but have introduced the hook-rest board A, the hooks D of one long row, the harness cords C from these hooks—neglecting the first and last—and the knots C^1 where three separate harness cords are indicated as being tied to each hook. Since there are 38 hooks D in the row, the illustration represents a 300's jacquard (38 hooks × 8 per row = 304 hooks), with 36 hooks tied up, or a mounting of 36 × 8 per row = 288 cords and hooks.

A tie-up of a compound character appears in Fig. 16, in which there are three distinct stripes:

1. The narrow stripe marked N.
2. The broad stripe marked B.
3. The medium stripe marked M.

In this example, the narrow stripe N appears six times, the broad stripe B three times, and the medium stripe M twice. The comberboard E is shown above the design, and marked out for the first and last rows and the front row in each section. It is arranged for a 600's or 12-row jacquard, to be tied up as follows:

48	hooks	for 1st	stripe N, 3	harness	cords	per hook	=	144
360	,,	,,	stripe B, 3	,,	,,	,,	=	1080
144	,,	,,	stripe M, 2	,,	,,	,,	=	288
48	,,	,, 2nd	stripe N, 3	,,	,,	,,	=	144
600								1656

i.e. 600 hooks utilised for the figure, and 12 hooks reserved for selvage threads, tape selvages, or the like.

The measurements of the various sections in the design and in the comberboard E are as under:

1st	stripe N is 0·5 in. wide.	
	stripe B is 3·75 in. „	
	stripe M is 1·5 in. „	
2nd	stripe N is 0·5 in. „	
	6·25 in. width of unit R.	

Hence

$$\frac{600 \text{ cords}}{6\cdot25 \text{ in.}} = 96 \text{ cords per inch, and } 96 \text{ threads per in. in the reed.}$$

It will be noticed that there is scarcely one complete repeat or unit of the broad stripe B in the way of the weft, whereas two repeats are shown in the medium-width stripe; no indication of the pattern is exhibited in the narrow stripes.

It will be apparent that if all the narrow stripes contained exactly the same design, it would be possible to tie up the machine so that 552 hooks and needles would be sufficient for the work; thus

$$\begin{array}{c} N + B + M \\ 48 + 360 + 144 = 552. \end{array}$$

In such a case, all the harness cords from the six narrow stripes would be controlled by 48 hooks instead of by 96 hooks as illustrated. Or a similar but wider pattern could be obtained by utilising all the 600 hooks of the machine, and making the stripe B, the stripe M, or both, a little wider, for there would evidently be 48 available hooks for such an increase in the figuring capacity. It need hardly be said that these 48 available hooks could, if desired, be utilised for increasing the width of each stripe N, and thus still further increase the width of the cloth without disturbing the sett or the general disposition of the various ornamental sections.

It will thus be seen that designs of the nature of that exhibited in Fig. 16 can be treated in different ways. In the first case, such designs may be woven on a loom in which the harness is a straight tie covering the extent of one complete unit of the design, in which case, with a set of 96 threads per inch, 600 needles and hooks would be in use; in the second case, those stripes which repeat themselves in any one unit can be reproduced by a number of needles and hooks which corresponds to the requirements for one such stripe only.

The former method may not appear so economical as the latter, inasmuch as it requires the greater number of needles and hooks—one for each separate thread of the pattern; moreover, in some cases, it incurs more expense in designing, as well as in cards and card-cutting. Nevertheless it is, in general, preferred, since the tie-up is capable of being utilised for patterns of all kinds which come within the capacity of the number of needles employed.

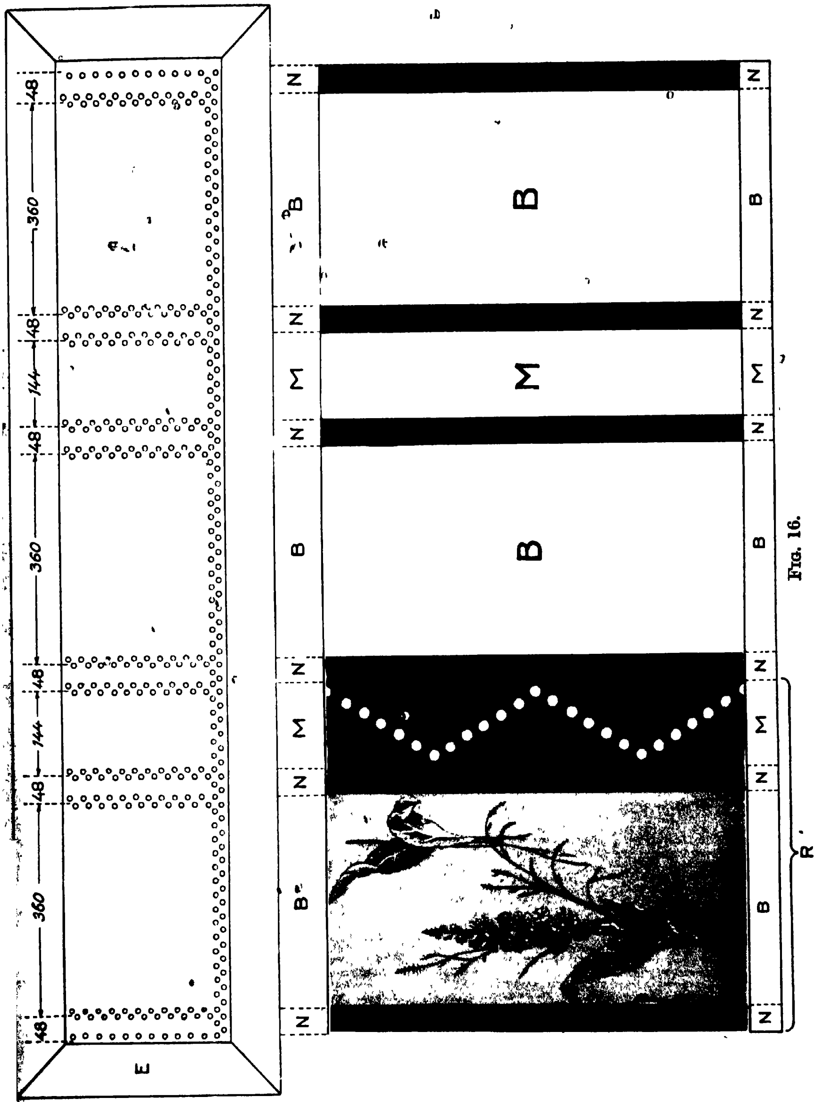


Fig. 16.

Fabrics which are ornamented at intervals by jacquard designs on clearly defined stripes are of two general types: (*a*) Those in which the stripes form an integral part of the fabric; and (*b*) those in which the stripe

is of an extra warp nature and forming some type of ornament which is superimposed on the surface of a foundation cloth, the threads of which are operated by healds or shafts.

Each of these groups covers an immense variety of fabrics and it often happens that, in order to simplify the working of the loom, the whole of the warp, both for the foundation cloth and for the warp figured stripe, is controlled from the jacquard. In examples of this kind, where all the threads pass through the mails of the harness, complications sometimes arise because the sett of the cloth in the pure ground portions is coarser than that in the figured stripe. When this occurs the sett of the harness in the comberboard must be varied in accordance with that of the warp in the different portions of the fabric, or else the sett all through must be as high as that required for the figured stripe, and the remainder cast out as required. In other cases the nature of the ground weave, or perhaps the character of the fabric, is such that the best results cannot be obtained by controlling the harness exclusively by the ordinary jacquard, and it becomes desirable, if not imperative, to use shafts and harness in combination. When such a departure is adopted, the harness tie is generally some modification of an all-over repeating tie, and the shafts are actuated either from a few spare hooks at each side of the jacquard, or independently by means of tappet or dobby mechanism. If the fabric is to be woven by the jacquard alone, it is usual so to arrange the tie-up, as already stated, that any simple weave repeating on a small number—say, four threads and four picks—may be introduced into the ground stripes without affecting the figured portion of the cloth or changing the cards which control it.

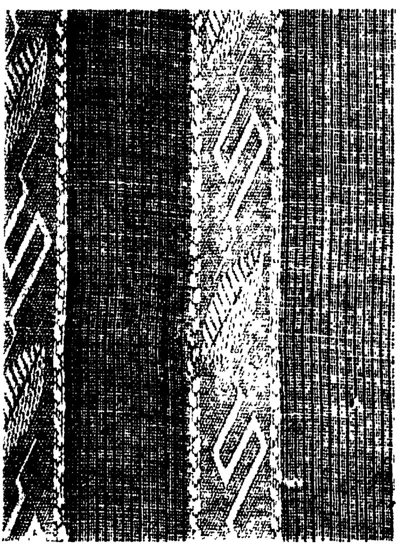


Fig. 17.

Fig. 17 illustrates a fabric of the type in which the figured stripe forms an integral part of the fabric. It is about five-eighths of an inch wide in the reed, and consists of 44 threads of two-fold mercerised cotton, with an

edging of four threads of artificial silk, all drawn three threads per split. In the plain portion, however, which is made up of 44 threads per inch of the two-fold mercerised cotton and woven $\frac{1}{1}$ plain, alternate splits of the reed are left empty, and the remaining ones contain three threads each; this arrangement of reeding the threads imparts a stripe-like character in the plain section not unlike bad reed-marking. The complete pattern contains three figured stripes, and therefore three plain stripes, but little more than half of the repeat appears in the illustration.

Now, on first sight it would appear quite probable that the fabric had been woven with a combination mounting of harness and shafts, since shafts undoubtedly conduce to better results in plain work than does the harness, and the plain-weave stripe in Fig. 17 is devoid of interlacing faults. A closer examination of the pattern, however, would probably lead to the conclusion that all the warp threads had been controlled by a jacquard. For instance, there are three figured stripes in the complete pattern, disposed in three different planes, although the ornament in all the three stripes is the same; hence, since each figured stripe contains 44 threads, the total number of figuring threads per pattern is $44 \times 3 = 132$ plus the artificial silk edging threads, four on each side, which are also controlled by the jacquard. If all the edging threads were controlled by 4 hooks, and the plain stripe neglected for the time being, there would be $4 + 132 = 136$ hooks required as a minimum. Consequently, unless some odd size of jacquard were used, a 200's machine would be necessary for the reproduction of the pattern, approximately 70 hooks being idle.

Suppose, on the other hand, that the threads of the plain stripe were also controlled by the jacquard, in the way illustrated by one repeat of the pattern in Fig. 18 plus 4 threads at the end. The solid black circles show where the edging threads appear. The arrangement is as under:

$$\left.\begin{array}{l}\text{4 edging threads}\\ \text{44 threads for plain weave}\end{array}\right\}\text{operated by 48 hooks.}$$

$$\left.\begin{array}{l}\text{4 edging threads}\\ \text{44 threads for figured stripe}\end{array}\right\}\text{operated by 48 hooks.}$$

This order is repeated for three times, but, although the plain part and the four edging threads in each section P, Fig. 18, are controlled by the same 48 needles and hooks, the four edging threads and the 44 figured threads in the section F^1 differ from those in F^2, and both differ from those in F^3. Hence, one could still employ a 200's machine as under:

48 hooks for one edging and plain threads three times repeated per pattern,
3×48 or 144 hooks for three plain edgings and three figured stripes,

thus utilising $48 + 144 = 192$ hooks out of a total of 208 hooks in an 8-row 200's machine.

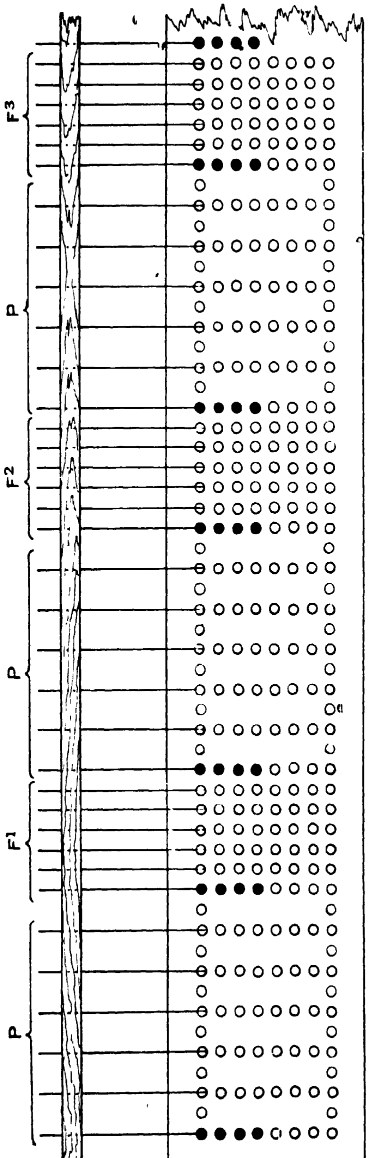


Fig. 18.

It has already been pointed out that the plain stripe is only half the sett of the figured stripe, so that alternate rows of the comberboard or harness reed would be empty as indicated in sections P, Fig. 18, provided that the sett of the comberboard throughout was equal to that required by the figuring stripes.

For the above method of tying up, the hooks of the machine would require harness cords as follows for each repeat of the pattern :

Hooks.		Harness Cords per Repeat.
1- 16 -	16 idle or utilised for selvages, etc.	
17- 64	48 for edging and plain cloth × 3 cords each	= 144
65-208 -	144 for edging and figured stripes × 1 cord each =	144
	208	288

If the cloth were made to contain seven repeats, each hook controlling the cords in sections P, Fig. 18, would require 21 cords, while each hook in the figuring sections, F^1, F^2, and F^3, would have only 7 cords.

We have already pointed out, in connection with Figs. 13 and 14, the advantages which obtain when a jacquard machine is tied up to a number

of hooks which is a multiple of 2, 4, 6, 8, etc., and we have also mentioned the fact that when the figured patterns are separated by any kind of continuous band, it is not absolutely essential that the number of threads in the weave should be a measure of the number of hooks in use. The pattern illustrated in Fig. 17 clearly belongs to that class in which the relation between the threads in the weave and the number of hooks is unimportant, since each of the three distinct patterns forms a band which effectively separates the others. The continuity of the various weaves is therefore important only in the way of the weft, but this is independent of the number of hooks. Such being the case, the pattern partly illustrated in Fig. 17 could be produced quite easily if an ordinary 300's jacquard be used in which the tie-up was of the straight-through repeating kind illustrated in Figs. 9 and 11, but with seven repeats instead of only three as illustrated in the above two figures. Thus:

4	threads	artificial silk for edge
44	,,	plain weave P
4	,,	artificial silk for edge
44	,,	figure weave F^1
4	,,	artificial silk for edge
44	,,	plain weave P
4	,,	artificial silk for edge
44	,,	figure weave F^2
4	,,	artificial silk for edge
44	,,	plain weave P
4	,,	artificial silk for edge
44	,,	figure weave F^3
288	threads, cords, and hooks for each pattern.	

The two edges of the cloth, near the selvages, would be developed with about half a pattern of the plain-weave stripe.

On page 26 we stated that fabrics ornamented by jacquard-figured stripes were of two general types—(*a*) those in which the stripes formed an integral part of the fabric; and (*b*) those in which the stripe was of an extra warp nature and formed ornament superimposed on a foundation cloth, the threads of which were operated by shafts. To that brief definition should be added the words, " or other suitable shedding mechanism." The chief point of difference between the two types is that in the former the threads which form the jacquard-figured stripe also help to build up the fabric proper, whereas in the latter type the stripe threads are used exclusively for the figure.

In connection with Figs. 17 and 18 we discussed an example which might be regarded as typical of the former class of stripe, but a discussion of any example of the latter type involves practically the whole question of extra warp figuring by means of a jacquard or jacquards independently of how

the ground warp may be controlled. Further, it is sometimes difficult to differentiate between those examples of extra warp figuring where, on the one hand, the extra warp is utilised for figuring purposes pure and simple, and, on the other hand, where the warp is so controlled that the fabric produced becomes less or more compound in nature as an indirect result of the method of figuring and also of stitching the loose figuring threads when they are on the back of the fabric. As examples of this class of fabric we may mention the cloths which are known generally in the cotton trade as toiletings and toilets, an elaborate example of which appears in Fig. 7. The variety in the structure of these fabrics forms a very fine gradation from what might be termed a true extra warp-figured cloth to what is virtually a double plain, but non-reversible compound cloth, in which the figuring is produced by the stitching together of the two fabrics. In the meantime, however, we shall confine our remarks to specimens of the former type, since the latter are usually produced by means of special compound harness mountings, designed to economise in the cost of designing and card-cutting.

FIG. 19.

FIG. 20.

Figs. 19 and 20 show respectively the face and back views of a cotton tapestry fabric of a simple type in which the chief ornament is developed with extra warp threads. The ground fabric is for the most part composed of the [illegible] plain weave, but relief is given to what would otherwise be a plain white surface by the introduction of green-coloured threads, and of floral ogee lines developed in ordinary white warp flush or float. A white satin

stripe, about one-quarter of an inch in width, is situated centrally between each pair of ogee lines, but these white stripes are broken at regular intervals by extra warp spots developed in green, red, helio, pink, orange, and yellow threads. The spots, which point to right and left alternately, are arranged in diamond form, or turned over drop order, and only one weft is used. The ground pattern repeats on 300 threads exactly; the sett of the ground warp throughout is 96 threads per inch, and the repeat, therefore, measures $3\frac{1}{8}$ in. It would be possible to operate part of the ground warp by shafts, but since the ogee ornament necessitates a jacquard, there would be little gained by adopting a compound arrangement; hence the ground warp would be controlled by 300 hooks. The white satin stripe threads in the centre change the order of weaving to 1 1 plain at those places where the coloured extra warp threads appear on the surface; this decrease in the length of float of the white threads enables the main figure to be developed more distinctly by the coloured threads. Each vertical line of extra warp spots consists of 80 threads—that is, 160 threads per repeat of the pattern. The order of warping is

1 thread figure ⎫ where green figuring threads only appear near the edges of
2 threads ground ⎭ the figure;

1 thread figure ⎫ where two colours of figuring threads appear in the same
1 thread ground ⎭ line.

As will be observed from the back view in Fig. 20, the extra warp threads have been stitched, or bound by the weft wherever possible—especially is this noticeable in the satin stripes—but near the tips of the leaves the extra warp has been permitted to float loosely between successive spots. There are approximately 56 picks per inch, and the pattern is complete on 144 picks, or $2\frac{4}{7}$ in.

Altogether 300 + 160, or 460 hooks, are required to control the warp threads; if only one jacquard machine were to be used it would be of that capacity, or, say, a 500's jacquard. The jacquard and harness would probably be mounted on the London or quarter-turn principle, and the first 300 hooks tied up as a simple repeating tie, with a sufficient number of repeats to make up the width desired. The comberboard would be divided into two horizontal sections of 10 rows each—the front section being utilised for the ground harness and warp, and the back section for the extra figuring warp, or vice versa, as is found to be most convenient. If, however, only one jacquard is used as indicated above, both ground design and extra warp figure would require to be painted on the separate parts of the design-paper, corresponding exactly with the positions of the needles of the jacquard which are to be so employed. This would be necessary in order that the whole card might be cut in one continuous operation. And

further, only one ground effect—that one designed—could be used with a given figure, since both would be cut on the same set of cards.

Another, and perhaps a preferable, method of harness mounting would be to employ two 8-row-jacquards, one, say, of 300 hooks, to control the ground warp threads, and the other, of 200 hooks, to operate the extra figuring-warp threads. Both machines would be mounted side by side on the London principle as mentioned above for the single machine of 500 hooks, and the comberboard would also be similarly divided into two longitudinal sections, but of 8 rows each instead of 10 rows each, for the ground and figuring warps respectively. Since two jacquards are to be employed, it is necessary to use two sets of cards, but both sets may be cut from the same sheet of design-paper if desired, although many designers prefer to make two separate designs, especially where the two designs are for machines of different capacities. If the former method is adopted, the ground pattern only is painted, and the card-cutter cuts the cards for the ground. After these cards have been cut, the extra warp figure is superimposed in its correct position on the ground design, and a separate set of cards are cut for this portion. Each set of cards must, of course, contain the same number of cards, or else be a measure or a multiple of the other set, and naturally they must move in unison card by card. To ensure simultaneous and accurate movements, it is usual to couple up the cylinders of the two machines (this is done in different ways) so that both cylinders cannot fail to turn as one. With this method of mounting, either the ground pattern or the extra warp-figuring design may be changed or modified without necessarily involving the recutting of the other set of cards.

When extra warp figures, such as that illustrated in Figs. 19 and 20, are produced by means of the London tie, in which the front comberboard, say, is utilised for the foundation threads and the back comberboard for the extra figuring threads, the number of holes per inch in the two boards may be the same, although the requirements in the two sections of the cloth may vary. The number of holes per inch in the comberboard for the foundation cloth if all the holes are occupied, would correspond to the number of ground threads per inch, and if in the extra warp sections the threads were arranged

1 thread foundation,
1 thread extra warp,

the pitch of the back comberboard should be as fine as that of the front one. All the holes in the front comberboard would be filled and the harness cords in work, but those in work in the back comberboard would correspond only to the width of the longitudinal extra warp stripes in the cloth, although every hole may be provided with a harness cord. This arrangement permits of any width of stripe, and at any place in the width of the fabric, being

made; any change in width or position would obviously necessitate the re-drawing in of the whole or part of the warp threads through the mails of the back or figuring comber-board.

Fig. 21.

The design-paper required would depend upon the ratio of the threads per inch to picks per inch, but the vertical ruling would be fixed according to the number of needles per short row in the machines.

Centre-ties.—As already mentioned, the centre- or pointed-tie is used for symmetrical patterns, although many symmetrical patterns are woven by the straight-through tie arrangement. The advantage which obtains in regard to the use of the centre-tie is that a much smaller number of needles and hooks are required; indeed, approximately one-half of the number required for the production of the same design by the straight-through tie.

Fig. 22.

Consider Fig. 21, which is a practical sketch for a figured fabric. With various degrees of modification, this sketch might be utilised for the production of designs which differ slightly in general form, but, of course, developed by the same types of ornament. There is one outstanding design, however, for which the sketch is suitable, and for which it is actually intended. That design is the one

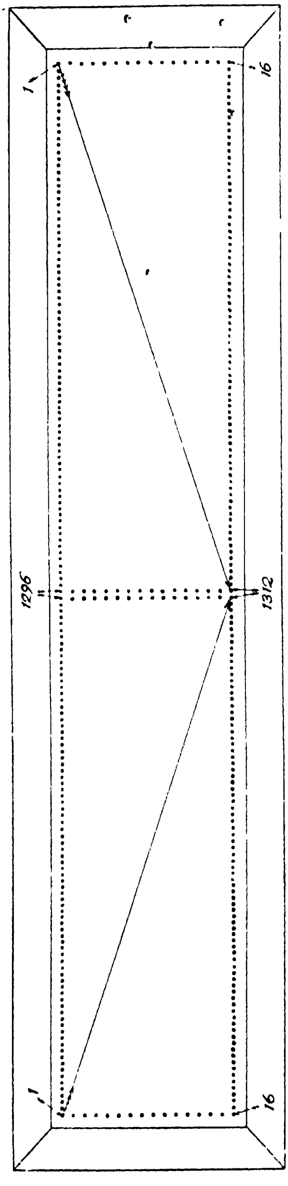


Fig. 23.

exhibited in Fig. 22, which illustrates a complete pattern.

A line drawn down the centre of Fig. 22 would yield two halves, each of which is the mirror image of the other. A horizontal line drawn through the centre would also divide the design into two halves, which are almost the mirror image of each other. The bottom left-hand quarter is identical with Fig. 21, and the design could be made, if desired, perfectly symmetrical about the above two lines.

If a $27\frac{1}{2}$-inch fabric were required with 96 threads per inch, and ornamented as shown in Fig. 22, it is clear that a total of $27\frac{1}{2} \times 96$ or 2640 threads would be necessary. On the straight tie-up principle, and with the full-harness method of weaving, it would be essential to employ jacquard machines with a total capacity of 2640 needles and 2640 hooks. But if the centre-tie principle be adopted, one machine with 1320 needles and 1320 hooks would be sufficient for the purpose.

Machines of such a high number of needles and hooks have 16 needles and 16 hooks per short row, and the centre-tie for such a machine is represented in the simplest manner in Fig. 23, utilising only 1312 needles, or 82 full rows of 16. These 1320-needle machines have actually a number of broken rows (see the card in Fig. 105, p. 135).

The first hook in the machine controls the first thread in the back row of the comberboard, as well as the last thread in the back row, while the last hook (1312) of the jacquard is shown

as controlling two threads in the middle of the front row of the comber-board. Although two holes are shown, it is usual to have only one cord and one thread in the middle, for if two were used as indicated, there would be a "flat" (two threads working as one) in the middle of the cloth.

The magnificent example illustrated in Fig. 24 could be, and probably was, woven on the centre-tie principle. The reproduction represents little more than one-half of a Paisley plaid in the possession of the author; the middle of the plaid is indicated by the two small arrows near the top of the illustration. The design abounds in detail which can only be seen in the photograph by the aid of a lens. There are eight different colours (black, white, green, yellow, blue, heliotrope, red, and dark red) in the fabric, beautifully blended, and the whole forms a type of texture which the Paisley designers and weavers of old have made world-famous.

Fig. 24.

Immediately above the fringe, near the bottom of the plaid, is a series of figures enclosed in different-sized rectangles. Near the top of the second rectangle from the left selvage are the letters JC, which might represent the initials of the designer; while near the top of the second rectangle from the right selvage the two letters are reversed and appear thus—Ɔ⅃. This feature alone is practically sufficient to confirm the statement that the harness would be centre-tied and, as indicated in Fig. 24, immediately below the illustration of the plaid. In passing, it might be stated that whereas a Paisley shawl is usually 2 yards by 2 yards, a Paisley plaid is 4 yards by 2 yards. There are therefore more than 4 square yards

illustrated in Fig. 24 ; hence the impossibility of seeing the very fine detail. The designs illustrated in Figs. 22 and 24 are extensive ones, and each is complete as demonstrated by one straight or single part up to the middle of the fabric, and then a similar but reversed half. As a matter of fact, the two designs mentioned are neither intended nor suitable for repetition. On the other hand, there are several designs of the centre-tied type in which there is a plurality of complete ornaments between the selvages.

Fig. 25 is a photographical reproduction of a reversible double cloth in which the figure, a comparatively simple one, appears as a coarse plain jute cloth upon a finer striped plain cotton cloth. There are two repeats illustrated, but any number of units could be utilised in the loom to make up the desired width of fabric. The cloth was actually woven in a 400's full-harness jacquard, although the design is complete on 200 threads. The fabric could therefore have been woven in a 200's jacquard, with the harness tied up on the repeating-tie principle, and as illustrated by the comber-board immediately above the cloth in Fig. 25. With a very slight modification in the weaves on the point-paper design the working design could have been made symmetrical, like the ornament, and hence the cloth could have been produced by a centre-tie on 100 hooks, as demonstrated by the comberboard diagram below the fabric.

When the designs are more or less extensive, as in Figs. 22 and 24, or even such as the one for Fig. 25, it is a distinct advantage from the economic side to use the centre-tie ; but in several cases there is a defective part in that longitudinal area bordering on the centre line. The employment of certain weaves—*e.g.* that in Fig. 25—does not introduce a defect, but these cases are more the exceptions than the rule. In other instances means can be taken to minimise the fault. We shall refer to this shortly. In spite of the defects, the centre- or pointed-tie is usually employed in whole or in part, where the ornament is similar in disposition to that in Figs. 22, 24, and 25.

The true centre-tie, as exemplified in Fig. 23, is not always used for the type of design shown in Fig. 22, because such designs, as well as others of a modified form, can be produced more economically by means of one standard type of tie-up or mounting. Thus the reproduction of the damask napkin or serviette in Fig. 26 shows clearly that the design is perfectly symmetrical, and could therefore be reproduced in a loom provided with the true centre-tie harness shown in Fig. 23 by choosing a sett or width of cloth to suit.

The fabric illustrated in Fig. 26 is typical in structure to those which are usually woven by means of jacquards of the self-twilling type—that is, twilling jacquards or Bessbrook jacquards—in which each needle of the jacquard controls two or more of the hooks or uprights. Since the warp threads are lifted in pairs (if there are two hooks per needle) it follows that

the contour of the ornament must be a little more rugged than if the cloth

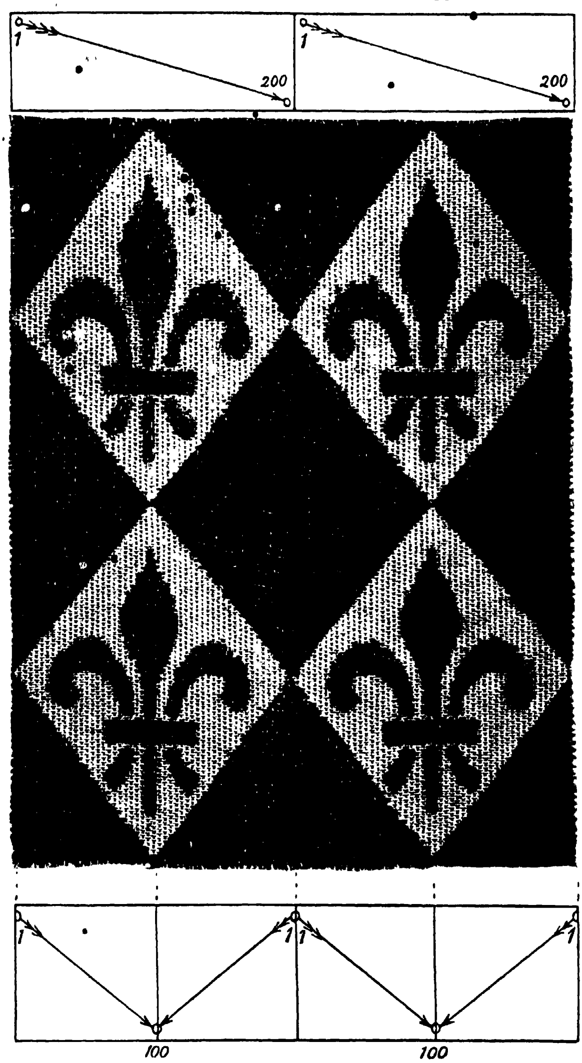


FIG. 25.

were woven by means of a full-harness jacquard. If the latter were employed for the sake of obtaining the best possible outline, a much larger

weight of cards would be required, unless some type of fine-pitch machine were used (see Figs. 99 to 107, for relative pitches of machines). In some of the twilling jacquards there are 3 or 4 hooks per needle, and 3 or 4 picks per card. But when each needle controls so many hooks, and each card serves for so many picks, the cloths have a considerable number of threads and picks per inch, and the defect in the outline of the pattern is

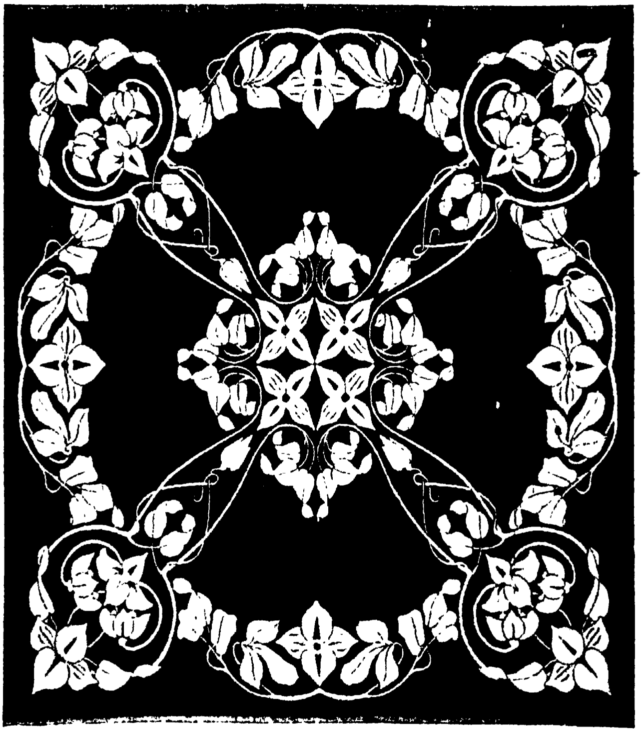


FIG. 26.

not very noticeable; indeed, it diminishes as the sett of the cloth increases.

The cloth represented by Fig. 26 is approximately 24 in. wide and contains in all 1920 figuring threads. If the harness were of the straight-through tie kind, and there were two hooks per needle, the arrangement would be equivalent to

$$1920 \text{ threads} \div 2 \text{ hooks per needle} = 960 \text{ needles.}$$

Again, if the harness had been true centre-tied—*i.e.* typical of that in Fig. 23, then the number of needles required would have been

$$960 \div 2 = 480 \text{ needles for centre-tie.}$$

In practice, a twilling jacquard of 600 needles, with 2 hooks per needle, was used—that is, 1200 hooks in all—but the harness was not tied up on the centre-tie principle, but on one variety of a mixed tie.

CHAPTER III

THE JACQUARD HARNESS: MIXED OR COMPOUND TIES

Mixed or Compound Ties.—Although the pattern in Fig. 26 could have been woven by means of a true centre-tie harness, it was, as stated, actually produced in a loom mounted with a mixed or compound tie. A tie of this type is a combination of a straight-through tie and a centre-tie; the two inner threads of the centre-tie are sufficiently far apart in the comber-board to admit of the whole of the straight-through tie being placed between them.

Fig. 27 is a diagrammatic view of the actual comberboard arrangement which obtained in the loom in which the fabric illustrated in Fig. 26 was woven. The two outer quadrilaterals represent the centre-tied part, while the smaller or middle quadrilateral is the straight-through part; they are placed obliquely for the sake of clearness. As indicated above the diagram, the terms "centre-tie" and "straight-through tie" are often distinguished by the terms "double" and "single." The holes in the boards are marked in four different ways, as shown by the particulars below the board.

The photographical reproduction in Fig. 28 is that of another cloth which was woven in the same loom as the cloth in Fig. 26, and also by means of the same tie-up as that represented in Fig. 27. It will be observed that, with the exception of a very narrow strip in the central part of Fig. 28, the pattern is symmetrical. Nevertheless, the narrow strip referred to makes it impossible to weave a cloth with this pattern by means of a true centre-tie. The narrow strip necessitates a corresponding width of single tie, but not necessarily as wide as the central part in Fig. 27.

The pattern in Fig. 28 is, as stated above, almost perfectly symmetrical in design, measures just under 24 in. in width, and contains 1920 warp threads. Additional threads are added near each selvage, which brings up the total width to 26 in. To weave the above cloth, as well as that in Fig. 26, both of which were woven in the Textile Department of the Dundee Technical College and School of Art, a 600's-needle jacquard of the self-twilling type was employed, in which each needle controlled two hooks. A figuring capacity of 1200 hooks was thus provided, but, since each needle

controlled two hooks, and therefore two contiguous threads of the warp, the outline of the figure must necessarily move in steps of two threads, although both threads are represented as one thread on the design-paper.

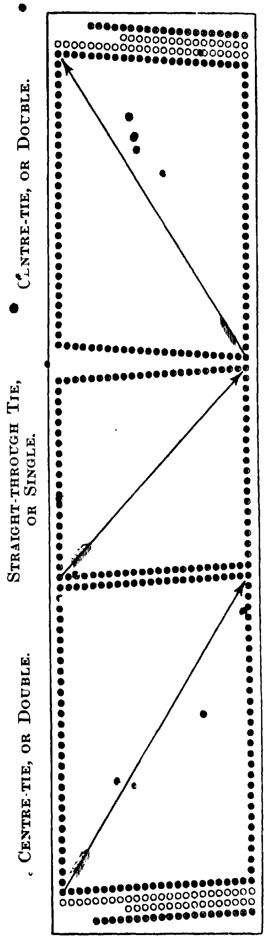


Fig. 27.

⊗ 4 threads plain weave, and 16 threads $\frac{2}{2}$ twill at each selvage operated by a small dobby at the side of the jacquard.

○ 40 threads 8 leaf sateen twill near each selvage operated by needles 1 to 12 and hooks 1 to 24.

● 1440 threads for left hand and right-hand borders, and operated by needles 13 to 372 and hooks 25 to 744.

◉ 480 threads for centre or straight portion, and operated by needles 373 to 612 and hooks 745 to 1224.

Similarly, the pattern must move in steps of two picks of weft since each card was presented to the needles for two successive picks. In addition to these unavoidable defects in twilling jacquards, which, however, are not very pronounced in this fine sett, it may perhaps be observed from the reproduction that the threads on one side of vertical straight lines are more

or less imperfectly bound, and have a tendency to move away slightly from their proper positions in the cloth.

The harness mounting employed to weave the cloths in Figs. 26 and 28 was of the part-centred and part-straight-through single-tie order, as demonstrated in Fig. 27. Of the whole 1200 hooks, the first 720 were tied-up centred, doubled, or turned over to produce the outside or side border

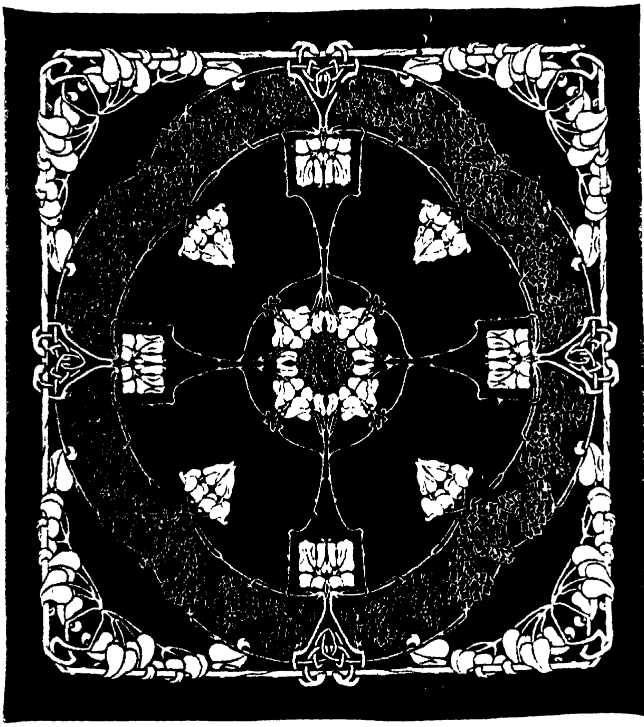


FIG 28.

portions, and the remaining 480 hooks tied-up all single, or with only one harness cord each for the central portion of the design. Since this jacquard (the back one in Fig. 10) has 24 hooks per short row from back to front, 30 short rows would be required for the turned-over portion and 20 rows for the single part, leaving one row of 24 hooks for side satins, etc. The comberboard or harness reed would necessarily have 24 holes in one row from back to front, as shown in Fig. 27, the succeeding rows being spaced

to give the required number of threads per inch in the reed. The different marks in Fig. 27 show where the various portions of the tie-up start and finish. The arrow in the right-hand quadrilateral points in the opposite way to that in Figs. 23 and 24, but in both cases the inference is that the draft is from front to back so far as the numerical order of the threads is concerned.

From a study of the design reproduced in Fig. 28, and as already stated, it will be evident that only a very small portion in the centre of the cloth is of an unsymmetrical nature, and therefore very few hooks and needles would have sufficed for its production—considerably less than the 480 hooks and 240 needles which were actually used in this case. While this is quite true, it must also be understood that if the jacquard had been mounted straight in the central part with only that number of hooks which the unsymmetrical part of Fig. 28 demanded, the central portion of all other designs for the same loom would have been limited as a maximum to the same number. By tying up the harness as indicated in Fig. 27, the jacquard is capable of producing any design of the general style shown in Fig. 28, from those which are perfectly symmetrical as exemplified in Fig. 26, to those in which the central non-repeating or single part, Fig. 27, occupies 480 threads. In the sett under notice this would mean that a central pattern of any type of ornament could occupy practically 6 in. in width.

$$480 \text{ threads} \div 81 \text{ threads per inch} = 5\tfrac{25}{27} \text{ in.}$$

To arrange a harness tie of a similar scope on the full-harness system would require at least 720 + 480, or 1200 hooks. With the standard British pitch, two 600's jacquards would be necessary, but one Continental jacquard of 1320 hooks capacity would be more than sufficient, and would be much more economical than the two 600's machines in regard to cards, although not so economical in this respect as one 600's self-twilling or common harness jacquard. The designing of the pattern for the latter machine would also be much simpler, and the cost much less than that for either of the other methods, although the resulting fabric and the outline of the figure are inferior to those which result from using the full-harness system.

Continental 1320's jacquards are usually composed of three sections of 440 hooks each; the whole machine contains 28 rows, each complete row consisting of 16 hooks. The first two rows and the last two rows of each section contain, however, only 14 hooks each, thus reducing what would otherwise be a 1344's jacquard to a 1320's. The omission of these four hooks at the beginning and at the end of each section takes place in the centre of the rows—*i.e.* the 8th and 9th hooks and needles—and it is essential that this should be the place, because the card cylinder and the

cards are designed with the pegs and peg-holes respectively in these positions. Each section of the jacquard cylinder is thus complete in itself, since it is provided with its own pegs, but the cylinder is all in one piece, and the corresponding card, although made up of three sections, is also in one piece. The very fact that rows of hooks, and therefore of needles, are incomplete at intermediate points, has a tendency to make designing and card-cutting difficult if these broken rows are included in the harness tie. The simplest method of overcoming the difficulty is to use 8-row paper, since there are 16 needles and hooks per row: and, since there are 4 successive rows of 14 hooks each—two rows at the end of one section and two rows at the beginning of the next section, or 56 hooks and needles in all—7 blocks of eight are used by the designer, and then ruled into 8 blocks of seven for the card-cutter.

In mounting such a machine, however, it is quite good policy to leave the first two and the last two incomplete rows for weaving selvages, satins, and such-like parts of the cloth, which are independent of the pattern proper, and to mount the harness with the remaining 1264 hooks. 1320 hooks − 56 for selvages, etc. = 1264 for the development of the ornament. When dividing this total number of hooks into two sections in the approximate proportions of 3 and 2 for the double or turned-over mounting and the single mounting respectively, it must be remembered that these sections must each be a multiple of the twill to be employed—the 8-thread twill in this case—and also that each section should, if possible, be complete on full rows of the jacquard. The former condition is essential for the correct repetition of the ground weave, while the latter minimises any tendency to error on the part of the harness tier or of the weaver. Both conditions are fulfilled if we select 760 hooks for the double mounting and 504 hooks for the single mounting. The machine would therefore be arranged as follows:

2 rows side satins, selvages, etc.	$2 \times 14 = 28$	= 28	hooks
48 ,, double mounting	$\left\{\begin{array}{r} 24 \times 16 = 384 \\ 4 \times 14 = 56 \\ 20 \times 16 = 320 \end{array}\right\}$	= 760	,,
32 ,, single mounting	$\left\{\begin{array}{r} 4 \times 16 = 64 \\ 4 \times 14 = 56 \\ 24 \times 16 = 384 \end{array}\right\}$	= 504	,,
2 ,, side satins, selvages, etc. .	$2 \times 14 = 28$	28	,,
		1320	,,

The ornamental part of the fabric is thus developed by

760	hooks double mounting,	*i.e.* 2 cords per hook	= 1520	threads
504	,, single ,,	*i.e.* 1 cord ,,	= 504	,,
1264	,,		2024	,,

Hence

$$\frac{2024 \text{ threads}}{81 \text{ threads per inch}} = \text{approximately 25 in. of cloth in all for the figured portion,}$$

while for the development of the unsymmetrical part of the figure, or rather for that part allotted to the single tie, there are 504 threads, and therefore

$$\frac{504 \text{ threads}}{81 \text{ threads per inch}} = 6\tfrac{2}{9} \text{ in. of cloth.}$$

The side satins, selvages, etc., for which 56 hooks have been allotted, would be practically identical with those in Fig. 27, except that the threads for these parts, as well as for all the others, would be in a comberboard arranged for 16 per short row instead of 24. The arrangement of the double and single portions would also be similar, although differing slightly in numbers.

The diagrammatic view of the comberboard above the design in Fig. 29, which is a different kind of design from the above, but arranged for the same kind of tie and the same numbers in each part, shows that the board would be divided into 8 sections: 3 sections at each side for the double part, and marked A, B, and C, and 2 sections in the middle for the single part, and marked D and E.

With a fixed number of threads per inch, the maximum width of cloth is obtained when the minimum number of hooks is used for the single part, and the maximum limit is therefore reached when the true centre-tie is employed, that is, when there is only one hook in the machine operating a single harness cord, the rest, of course, operating two harness cords each. The minimum width of cloth results when the design is produced by means of the straight-through tie. Any width of cloth between these two extremes can be obtained with designs such as that in Fig. 26.

The harness tie above the design in Fig. 29 is for a cloth which is neither a maximum nor a minimum in width. The tie and the preceding particulars show clearly that there are 504 hooks set apart for the single, while the harness tie below the design indicates that there are one-half of the total number of hooks in the jacquard allotted for the single. The adoption of the lower harness tie would therefore result in a narrower fabric than obtains with the upper harness tie. Indeed, the arrangement would be as under:

[TABLE

2 rows side satins, selvages, etc.	$2 \times 14 = 28 =$	28	hooks
40 rows double mounting	$\left\{\begin{array}{r} 24 \times 16 = 384 \\ 4 \times 14 = 56 \\ 12 \times 16 = 192 \end{array}\right\}$	$= 632$	„
40 „ single mounting	$\left\{\begin{array}{r} 12 \times 16 = 192 \\ 4 \times 14 = 56 \\ 24 \times 16 = 384 \end{array}\right\}$	$= 632$	„
2 „ side satins, selvages, etc.	$2 \times 14 = 28$	$= 28$	„
		1320	„

Then

632 hooks double mounting, *i.e.* 2 cords per hook	=	1264 threads
632 „ single „ *i.e.* 1 cord „	=	632 „
1264 „		1896 „

as compared with 2024 figuring threads required by the upper tie in Fig. 29. $2024 - 1896 = 128$ threads, or approximately $1\frac{1}{2}$ in. narrower cloth resulting from the lower tie as compared with the upper tie in the same figure. The same width, 25 in., could of course be obtained by using a lower sett of cloth for the lower tie.

The design in Fig. 30 is identical in ornament with that in Fig. 29, but black areas in one are represented by white areas in the other and *vice versa.* The harness tie below the design in Fig. 30 illustrates the minimum number of hooks and needles, and, of course, the maximum width of fabric which can be obtained in any given sett. The single part is the figure enclosed between the two vertical lines which pass through the design, and from it to the lower comberboard to denote the relative width B on the latter. The relative widths of the double part A and the single part B are 62 to 24; hence

$$1264 \text{ hooks} \times \frac{62}{86} = \text{approximately } 912 \text{ hooks for the double part A, and}$$

$$1264 \text{ hooks} \times \frac{24}{86} = \text{approximately } 352 \text{ hooks for the single part B.}$$

Altogether $912 + 352 = 1264$ hooks as before.

Therefore, we have

57 rows $\times$ 16 = 912 double $\times$ 2 cords per hook	=	1824 threads
22 „ $\times$ 16 = 352 single $\times$ 1 cord „ „	=	352 „
„ 1264 hooks		2176 „

In the three tie-ups already considered with respect to Figs. 29 and 30, we have assumed a 1320's jacquard of a fine pitch. Suppose, however, it were desired to make a fabric of the same width, but with a large number of threads per inch, say one that required 1800 hooks. Two fine-pitch

machines would, of course, be ample, but for a change we shall assume that the British pitch is used. Here again, two 900's jacquards would be sufficient, but instead of using these large British-pitch machines we shall utilise three ordinary 600's machines.

FIG. 29.

Three 600's British-pitch machines take up a considerable width on the loom gantry or rails, and it is desirable that the harness cords should make as big an inside angle as possible with respect to the comberboard. Hence, it is a common practice to arrange the three machines as indicated above the design in Fig. 30. No. 1 machine controls the harness cords and threads

on the outsides, *i.e.* towards the two selvages of the cloth. If this machine were placed on the extreme left, instead of as indicated, a very small angle would be made on one side of the loom between the harness cords and the comberboard. In the upper diagram in Fig. 30 it will be seen that the

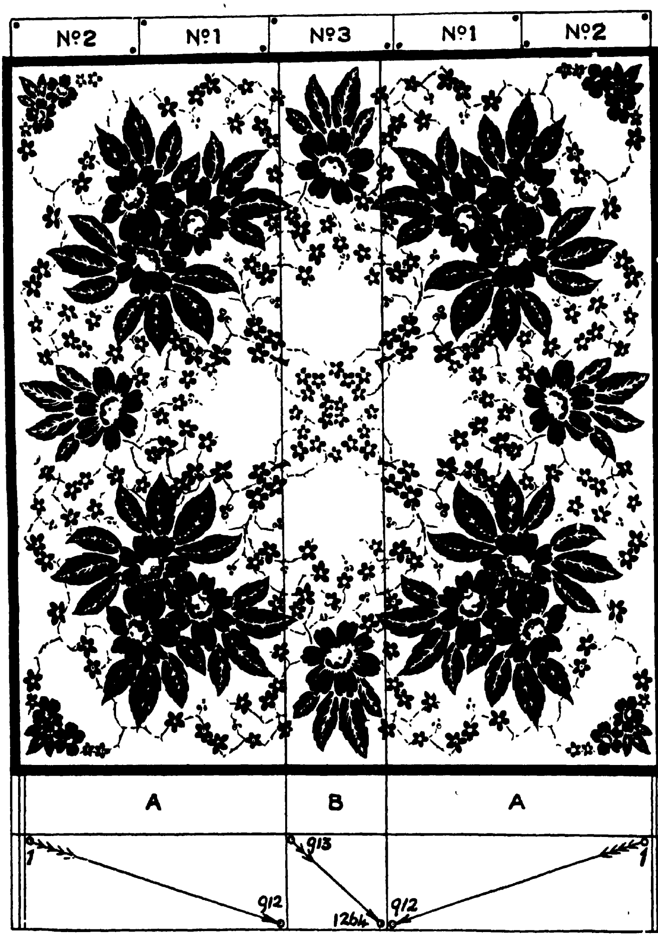


FIG 30.

third machine is utilised for the single, and that this single part is greater than the minimum. If the cloth is exceedingly wide, it is often desirable to introduce an extra 600's jacquard, or four machines in all, so that the disposition of the four jacquards would be as represented in Fig. 31. Indeed,

in order to make a perfect design of certain types on the fabric, it would be essential, as will be demonstrated shortly, to adopt the method illustrated in Fig. 31. In such cases, Nos. 1 and 4 appear on the outsides because each machine controls only those harness cords and threads near the selvage at the same end of the loom as the jacquard is situated.

Bordered designs of the type illustrated in Figs. 22, 24, 26, 28, 29, and 30 are certainly elaborate, but whatever system of weaving is adopted, the particular type of harness mounting which is necessary for their reproduction in cloth is comparatively simple. And, although the expense in designing, cards, and card-cutting for such fabrics is considerable in connection with common harness weaving by twilling jacquard looms, it is very much more increased, as shown on p. 67, when the fabrics are produced by the full-harness or brocade method of weaving. Consequently, the above-mentioned patterns, especially when applied to wide cloths, are developed by specialised forms of weaving, such as the self-twilling jacquard in the fine linen damask industry, the compound jacquard and multiple movable comberboards in the Scotch carpet industry, the similar combination in the quilt industry, and other combinations for somewhat similar fabrics, for

N°1	N°2	N°3	N°2	N°4

FIG. 31.

which the cost of designing and card-cutting and the number of cards required are reduced to a minimum. For such work it is not uncommon to find extensive patterns of the type indicated made in several different widths.

On the other hand, the greatest economy prevails when the width of the cloth in bordered fabrics is obtained by repetition of one or more parts of the ornament, chiefly the filling or field of the cloth. Perhaps the commonest form in this respect is where a comparatively bold border, centre-tied, is accompanied by some simple ornament in the field or filling of which several repeats are introduced usually on the repeating-tie principle, but occasionally on the centre-tied principle.

Consider, for example, the illustration in Fig. 32, the upper part of which represents approximately one-half of a lace curtain. There are different ways of arranging the harness for the production of such a texture, but for the purpose of illustrating the above-mentioned principle in regard to bordered designs, we have introduced a diagram of a comberboard arrangement below the lace design. It is assumed, for demonstration purposes only, that the pattern is to be developed by means of one 600's jacquard; 400 needles and hooks, or two-thirds of the machine, are utilised for the

border or double part, and 200 needles and hooks for the repeating part in the filling or field. Two repeats of the latter are illustrated, but it is evident that if, for any reason, it were required to make a wider curtain with the same 600's jacquard, it could be done by inserting one or more extra units of the filling repeat; all these repeats, however many were introduced, could be controlled by needles and hooks 401 to 600 inclusive.

It is not difficult to see that the harness for the filling or field part of the design could be tied up on the centre-tie principle, in which case 100 hooks would be sufficient for that section of the cloth, or 500 hooks in all instead of 600 as illustrated.

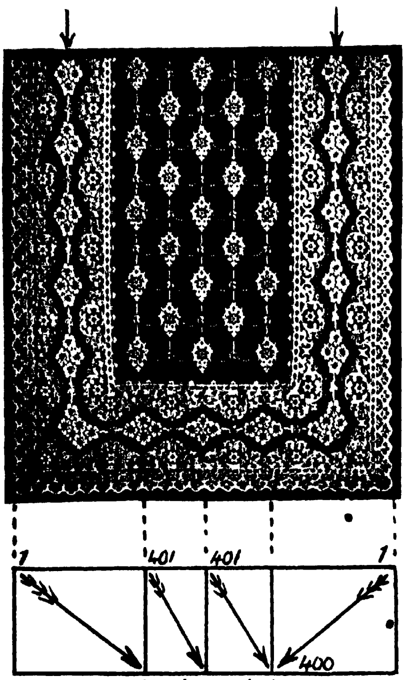


Fig. 32.

At first sight it looks as if an even further reduction could be made, because the greater part of the side border is symmetrical about the vertical division indicated by the short arrows at the top of the design. It will be seen, however, that the corner figure is not symmetrical about the above vertical division, and hence no reduction in the number of needles and hooks can be made in the border.

A photographical reproduction of a carpet is shown in Fig. 33. Such carpets may be made in what are called "squares," that is, woven full width in the loom, but the one illustrated suggests that it has been made in comparatively narrow widths, say 27 in. wide, and then these narrow widths are sewn together. Moreover, the widths are probably equal to the divisions in the upper comberboard diagram, all the sections of which are the same size.

The four sections of cloth indicated, *e.g.* the left-hand border, the two repeats of the field, and the right-hand border, were probably woven at different times with a straight-through tie-up equal in width to any one of the sections. Indeed, if the carpet happened to be a Brussels or Wilton make, the various widths would be woven separately in a loom similar to

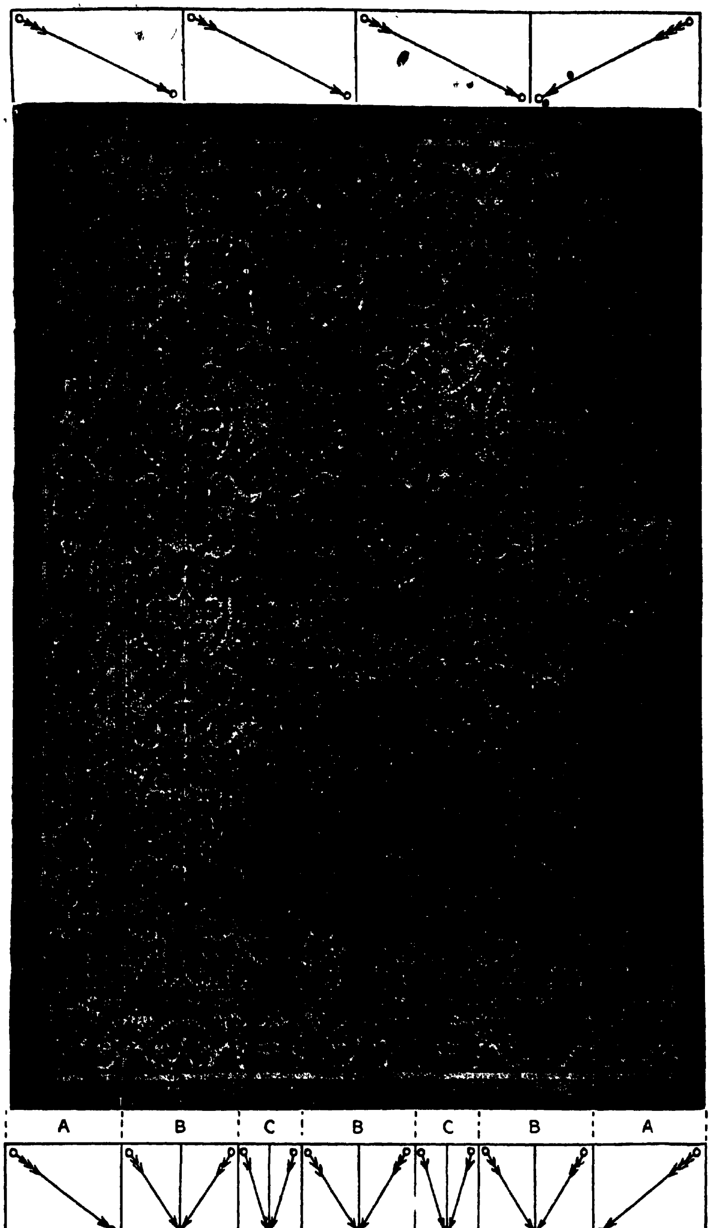


FIG. 33.

that illustrated in Fig. 34. A very interesting feature about this loom is that the original is a perfect model on a small scale of a Brussels or Wilton carpet jacquard, and that all the wood patterns were made, and the loom erected for exhibition by a Dundee carpet weaver named John Grant. The result is a splendid tribute to patience and skill.

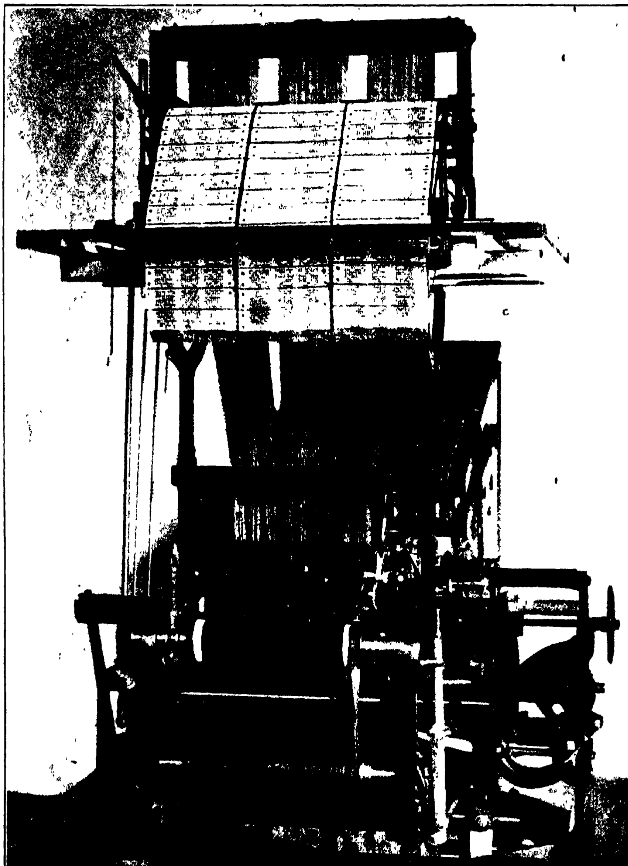


Fig. 34.

The three sets of cards shown near the top of the machine in Fig. 34 are required for one 27-in. width of carpet, say the left-hand border represented by the comberboard above the fabric in Fig. 33. A different group of three sets of cards would be required for the right-hand border; while a further group of three sets of cards would be used for the two central

widths. If a carpet were required for a wider room, one or more extra widths could be woven with the third group of cards, and these extra widths, which would be identical with the two central widths, would be introduced between the two side borders to make up the desired width. The place of introduction of the corner pieces and the cross border would be determined by the length of the carpet. The loom in Fig. 34 will be referred to again in connection with the cutting of cards for such looms.

There is a second comberboard diagram below the main illustration in Fig. 33. If for demonstration purposes we suppose that the design is to be developed for a brocade or ordinary full-harness loom we can utilise any kind of tie-up. It will be noticed from the lower comberboard diagram that the pattern or design lends itself to a great reduction in the number of needles and hooks as compared with the straight-through method of mounting; indeed, the diagram shows that there may be three distinct sections arranged with centre-ties. It might not be advisable, however, to adopt such a method of mounting in practice, for it will be well known that if such a course were followed, all designs woven in that particular loom would require to be similar in symmetry to that illustrated. Nevertheless, with the tie-up illustrated, and with a 1200's jacquard, either of the two following arrangements could be used:

	Part A.	Part B.	Part C.	
Arrangement I. . . .	624	384	192	=1200
Arrangement II. . . .	600	400	200	=1200

and each part would be centre-tied as indicated in the lower diagram in Fig. 33.

Fig. 35 is an elaborate sketch for a very fine linen damask intended to be woven by three 600's twilling or Bessbrook jacquards, or 1800 hooks in all, each needle to control two hooks. This method of weaving is somewhat similar to that obtaining in "pressure-harness" weaving. Most, although not quite all, of the design which is necessary for transference to design or point-paper is shown in this sketch. The parts were intended to be allocated to the three machines A, B, and C, but in the positions indicated by these letters immediately below the sketch. The two parts B and A are centre-tied or double, but the part C is single. Consequently, there would be five sections in the complete cloth, as well as in the comberboard; the tie-up is really identical with that illustrated in the upper comberboard diagram in Fig. 30. Since there are two hooks per needle in each jacquard, it follows that there would be

600 hooks × 2 cords × 5 sections = 6000 figuring threads in the cloth.

The total number of hooks in the three machines is 3600, and these are equivalent to six ordinary 600's jacquards, or nine ordinary 400's

jacquards, or their equivalents, for the full-harness or brocade method of weaving.

The sketch in Fig. 35, besides being marked B, A, and C for the three 600's twilling jacquards and for 3600 warp threads, or three-fifths of the total 6000 figuring threads, is also marked D, E, and F on the left to represent three similar sections in the direction of the weft. If there were no repetitions in the different parts of the working sketch in Fig. 35, nine sheets of 600-by-600 design-paper, or 600 by some other suitable number, would, as will be seen, be necessary for the card-cutter. The corresponding nine squares in Fig. 35 have not been marked by horizontal and vertical lines, but they are represented by the undermentioned combinations of intercepting letters :

$$\left.\begin{matrix}\text{BD}\\\text{BE}\\\text{BF}\end{matrix}\right\}\text{first three vertical squares controlled by machine B.}$$

$$\left.\begin{matrix}\text{AD}\\\text{AE}\\\text{AF}\end{matrix}\right\}\text{second} \quad ,, \quad ,, \quad ,, \quad ,, \quad \text{A.}$$

$$\left.\begin{matrix}\text{CD}\\\text{CE}\\\text{CF}\end{matrix}\right\}\text{third} \quad ,, \quad ,, \quad ,, \quad ,, \quad \text{C.}$$

Fig. 36 represents diagrammatically the above nine squares, as well as the remaining six on the right which would be obtained by the duplication of the harness for the two parts B and A. The ornament in the two sets of vertical squares on the right would, of course, be reversed, as is indicated by the changed effect of the letters. This sketch shows at once the difficulties met with in regard to the introduction of letters and words.

The lower diagram in Fig. 36 represents the plan of the comberboard, the arrow heads being marked in three different ways to distinguish the relation between the three distinct parts.

The three squares in each vertical group in Fig 35 are quite different in regard to the sectional designs which they embrace, but it will be observed that the square in Fig. 35, corresponding to the square marked CD in Fig. 36, is practically identical with that square in Fig. 35 which corresponds to the square denoted by BF in Fig. 36, provided that the square immediately above C in Fig. 35 be turned 90 degrees clockwise and thus placed in the position of that square immediately to the right of F (see also Fig. 36). Then what represents warp in CD may represent weft in BF and *vice versa*, and the altered position of the former square would place it in the correct position for the latter square.

A section of the design in the cross border (say CD in the horizontal direction of the design) controlled by one machine, say C, can be utilised

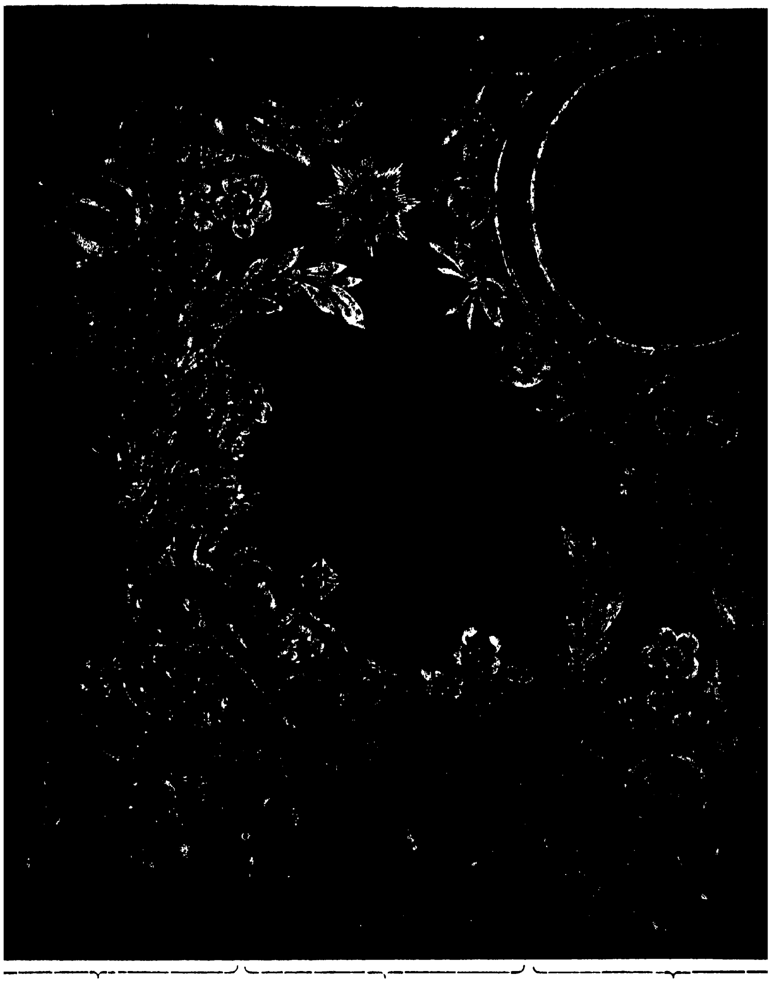


Fig. 35.

To face pa

for a section in the side border (say BF in the vertical direction of the design) and controlled by a different machine, say B, when the design-paper is ruled the same in both directions, thus, 12-by-12, 16-by-16, or any other suitable number according to the kind of jacquards which happen to be employed. But if the ruling of the design-paper in the vertical direction differs from the ruling in the horizontal direction, a special sheet of design-paper would have to be prepared for each, although the ornament in the two sections was identical in form, but differing in direction, as is emphasised by the above two squares in Fig. 35, represented in Fig. 36 by the two squares CD and BF. Hence, under the most favourable conditions, the design in Fig. 35 would require eight large sheets of 50-by-50 large blocks in each direction, or 600-by-600 small squares; while nine similar large sheets of 50-by-50 large blocks would be essential if the ruling of the paper in the two directions were different. The ruling of each large block for a 600's machine may be 12-by-12, 12-by-13, 12-by-14, 12-by-15, 12-by-16, or 12-by-18, depending upon the excess of weft required over the amount of warp. When any of these conditions, other than the 12-by-12, obtain, the cloth is said to be overshotted.

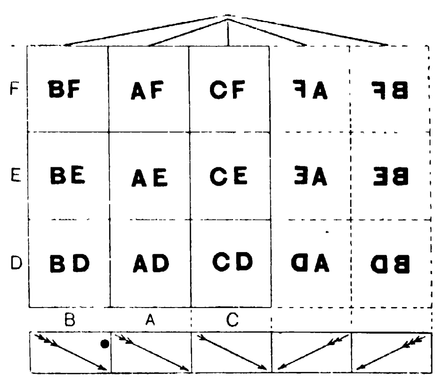


FIG. 36.

When an ornamental sketch, such as that illustrated in Fig. 35, has been prepared as the subject to be reproduced on cloth, it is often desirable, and sometimes necessary, to make alterations in order that the sketch may be more suitable or practicable for reproduction than it was in its original state. Perhaps the chief cause for alteration is that for changing the sketch in detail so that the point-paper design may suit a loom which is already mounted with a particular harness tie. This demand for a change in proportion will be met mostly by commission designers, and not often by those who are in more direct touch with the factory requirements. Again, the reconstruction of certain parts is often suggested and carried out with the object of improving the general effect. This was done with the medallion in section CF, Figs. 35 and 36, as is emphasised by the corresponding portion of the design which occupies the central part of the complete design illustrated in Fig. 37. Thus, while the general treatment of the outer circle

of ribbons, chain, and medals is the same in both cases, the introduction of the visor in the upper part of the ornament with the lower section overlapping the garter made it essential to change the order or position of the words in the motto "Honi soit qui mal y pense" as demonstrated. The central figure of the design will, of course, be recognised as the portrait of the late King Edward VII., and the delineation of the Royal Sovereign, as well as all the ornament which surrounds it, comes out beautifully in the cloth, of which Fig. 37 is a facsimile.

This particular illustration is a reproduction from a fine linen damask tablecloth, and such twilling jacquard designs are almost invariably made with more picks per inch than threads per inch or overshotted, in order to show up the figure. If 12-by-18 paper were used, and two picks per card adopted, it is evident that the cloth would be 50 per cent overshotted. It so happens, however, that the point-paper design for this cloth was made on 12-by-12 paper, and hence to obtain the same relation of picks to threads —*i.e.* 50 per cent more picks per inch than threads per inch—three picks for each card had to be inserted during the process of weaving. The effect on the cloth, as already stated, is splendid, but an even better effect would clearly have resulted if the design had been made on 12-by-18 paper with two picks per card, for then the steps on the contour of the ornament would have been in two of warp and two of weft, whereas the method adopted resulted in steps of two in the warp and three in the weft.

The letters B, A, and C in the first three sections of the design in Fig. 37 correspond to the similar letters in Figs. 35 and 36, while the comberboard or harness reed arrangement in the latter figure, and the forward and reverse positions of the letters, emphasise the similar relations in Fig. 37. It will be noticed, however, that the letters D, E, and F in Figs. 35 and 36, which represent the length of the sheets of design-paper, do not appear in Fig. 37, but that the weft for the complete design in the latter is represented in the vertical direction by the sections G, H, and G. The two sections G show that the design in these parts is the same but oppositely directed, and therefore the cards for the lower section G can be utilised for the upper section G, provided that they are made to rotate in the forward direction for one section and in the backward direction for the other section ; on the other hand, there is no repetition of the ornament in the central section marked H. In the actual process of weaving, the cards for section H, those for the upper section G, and those for part or half of the plain or simple twill portion between two successive cloths, would work in the forward direction, and would be reversed to weave the remaining half of the plain part between the cloths and the lower section G. Finally, it would be necessary to turn back the cards by hand, or to reel them back, until those

Fig. 37.

To face page 6

cards for section H are opposite the needles, when the cycle of operations would be repeated.

The diagrammatic view in Fig. 38 will explain this operation. Here two complete cloths and part of a third are exhibited, and the short arrows indicate the centre of the plain or simple twill part which separates successive cloths, and where the fabric would be cut in the finishing department or in the warehouse to detach the individual cloths. Similar letters to those in Figs. 35 to 37 are used, and the two additional letters, L and M, indicate respectively the start and the finish of the cycle in regard to the manipulation of the cards. This particular place L of starting the cycle is advantageous in all weaving operations where cross-borders are necessary, and the method is probably more valuable in connection with the measurement of towels or cloths developed by simple weaves, than with those with artistic elaboration, for since both cross-borders—the finish of one cloth and the commencement of the next—are woven at the beginning of the cycle or measurement, it is evident that, in the case of simple weaves, the cycle may finish exactly when the tape, cord, or chain measurement reaches the point M, and thus all the cloths should be of equal length. The same accuracy could only, if at all, be achieved with great difficulty if the cycle started and finished at the actual beginning and end of each cloth.

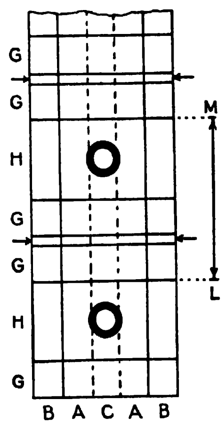


FIG. 38.

We might now with advantage point out one or two objections to the free use of certain types of ornament displayed in Fig. 37, keeping in mind the fact that the objectionable features could be overcome only by a considerable increase in the expense of production, and in this discussion the design in Fig. 37 shall be compared with other designs which are of a pure floral character. Thus, Fig. 39 illustrates the working sketch of a design, while Fig. 40 shows what the design would be like when developed on the cloth; again, Fig. 41 is a similar working sketch to that in Fig. 39, but with a different subject for ornamentation. Both designs could be placed on point-paper for the same harness mounting to three machines as that which was adopted in the loom in which the cloth for Fig. 37 was woven.

The duplication of approximately two-thirds of the working design in Fig. 39 by the harness tie, and by the reversal of about the same proportion of the jacquard cards, introduces neither objectionable features nor faults in the complete design in Fig. 40; and if the working sketch in Fig. 41 were

completed in a similar way, the result would be just as perfect as that in Fig. 40. This can easily be proved by placing the edge of a mirror along-

FIG. 39.

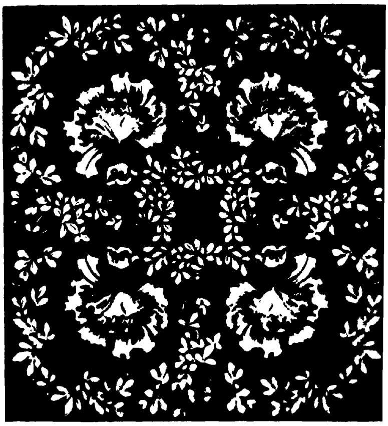


FIG. 40

side the right-hand edge of the sketch, and then along the top edge, or by placing a right-angled mirror along the two edges; the latter will show the effect of the double reversal of the harness tie and cards respectively. One cannot say the same for the corresponding treatment of the sketch in Fig. 35, and a close examination of the complete design in Fig. 37 will be sufficient to prove this statement. No faults are observable in Fig. 35; it is only when the duplication in the reverse order by the harness tie and by the cards takes place, as exemplified in Fig. 37, that the defects appear so distinctly.

FIG. 41.

The most glaring defect in Fig. 37 is the ornament which represents the

monogram at J and at K; in both cases the arrangement of the letters E R has been reversed, somewhat as illustrated by similar combinations in Fig. 36; the result is, therefore, quite wrong. The combination in the reversed order would have been even worse if the Roman numerals VII., which appear in Fig. 35, had not been omitted in Fig. 37.

Again, while the design of the Royal Arms is correct in two corners of the design, the effect in the other corners is wrong, because the ornament is not symmetrical about a diagonal line from the corner. The reason why the design of the Royal Arms in the upper right-hand corner is correct is because the equivalent of a double mirror image has taken place; the first mirror image reverses all parts, while the succeeding image of this reversed order yields the original ornament.

It will thus be seen that, when any distinct order of the component parts of an unsymmetrical section of a design has to be maintained, that section should not be operated by centre-tied harness, but should be under the control of what is known technically as "single harness," *e.g.* a part similar to that lettered C in Fig. 37. It will be evident that even in this part it would be necessary to cut a new set of cards for the upper monogram. The only way of securing the correct positions of the letters at K would be by allocating the harness cords for that part of the design to another jacquard machine, as demonstrated in Fig. 31; and the same remark applies to the procedure which would be essential to obtain a facsimile of the Royal Arms on the right-hand side. This operation, in turn, would necessitate a new set of cards for the upper right-hand delineation of the Royal Arms, and hence it might be said that such a design as that illustrated in Fig. 37 could be made perfect only by the use of separate needles, hooks, and harness cords for the five sections, and therefore, in the same sett, by the employment of five jacquard machines, and a number of cards which correspond to the length of the design. If this equipment were adopted, the various twills could be inserted and reproduced in the cloth without any change in direction—a condition which is impossible to achieve in connection with the usual centre-tied harness; but it is obvious that, unless in very rare circumstances, such a procedure would be prohibitive. It will now be clear why the mottoes "Honi soit qui mal y pense" and "Dieu et mon droit" have been omitted from the Royal Arms in the four corners of the design in Fig. 37, and from the sketch in Fig. 35.

As a matter of fact, it is usual to reduce the width of the single tie to a minimum in order that the most may be obtained from a minimum number of needles and hooks of the jacquards. To demonstrate this we shall refer again to Figs. 35 and 37. The motto on the two designs is arranged concentric with the circles of the garter, but if we place the lettering in straight

planes their dispositions are equivalent to the following. In Fig. 35 it appears as

Honi Soit Qui Mal y Pense.

In Fig. 37 it appears in two parts as

Honi Soit Qui Mal
y Pense.

If the only reason for changing the arrangement from that in Fig. 35 to that in Fig. 37 were that of allowing the lower part of the visor in 37 to overlap the garter, it is evident that the part " Honi Soit Qui " in Fig. 35 might have been moved counter-clockwise, and that " Mal y Pense " might have been moved clockwise to create the necessary gap for the bottom part of the visor in the centre, and thus obtain an almost perfect division of the words in the motto. It is equally evident that such an arrangement would have increased the number of needles and hooks which it would be necessary to employ in connection with the single tie for the development of this increased width of unsymmetrical ornament. On the other hand, the arrangement adopted in Fig. 37 actually decreases the width represented by the motto in Fig. 35, and hence decreases the number of needles and hooks for the single tie. Consequently, instead of employing one complete 600's jacquard for the single tie, as demonstrated in Fig. 36, and as suggested by the letters C in Figs. 35 and 37, a much smaller number of needles and hooks were used in practice, and Fig. 42 illustrates the method of achieving the result in Fig. 37 by reducing the single tie to the lowest number of needles and hooks. Indeed, it is quite possible that a harness mounting was already in use on a loom, and that the modification of the sketch was made to suit the existing mounting.

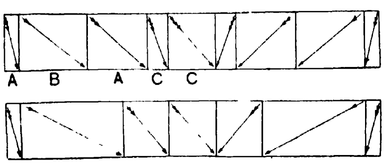


FIG. 42.

The upper rectangle in Fig. 42 shows the comberboard or harness-reed arrangement for three 600's machines, while the lower rectangle shows the equivalent arrangement for two 900's machines. The letters B, A, and C under the upper comberboard or harness-reed diagram refer again to the parts of the harness controlled by the three different jacquards, while the lower similar diagram shows that one 900's machine takes all B and part of A, while the other 900's machine takes the remainder of A and all C. The narrow strips at the ends of both diagrams indicate the single-weave or " satin " stripes between the tape-edges of the cloth and the beginning and finish (left- and right-hand edges) of the ornament displayed in Fig. 37.

If 72 needles are utilised for the satin stripes or strips, as these parts are technically called, the harness-tie arrangement for the two methods illustrated in Fig. 42 would be as tabulated below :

1st Method

600 needles and		1200 hooks for double			
{ 72	,,	,, 144	,,	,,	satin
{ 528	,,	,, 1056	,,	,,	
{ 180	,,	,, 360	,,	,,	
{ 420	,,	,, 840	,,	single	
1800		3600			

2nd Method

900 needles and		1800 hooks for double			
72	,,	,, 144	,,	,,	satin
408	,,	,, 816	,,	,,	
420	,,	,, 840	,,	single	
1800		3600			

The cloth was woven in what is known in Dundee and the East of Scotland as a 55-porter reed, with 3 threads per split, equal to an 82½-porter reed, with 2 threads per split. Therefore, if 77 in. reed width were required for a 72 in. finished cloth, termed an eight-quarter cloth, and written 8/4 cloth, there would be

$$\frac{55 \times 20 \times 3 \times 77}{37} = 6868 \text{ threads.}$$

55-porter 3's, or 82½-porter 2's, is equivalent to 11$^{\circ\circ}$ sett (eleven hundreds) on 37 in. scale. For full particulars on setting, see the author's work on *Healds and Reeds for Weaving : Setts and Porters*. This sett represents 89 threads per inch in the reed.

With either of the above harness mountings there are 1308 needles and double the number of hooks for the double or centre-tied part of the ornament, and 420 needles and double this number of hooks for the single or straight part of the ornament. Hence, we have

$$\begin{aligned} 2\,(1308 \times 2) &= 5232 \\ 1\,(420 \times 2) &= 840 \\ \hline & 6072 \end{aligned}$$

∴ 6868 threads − 6072 threads = 796 threads to be utilised for the satin strips and for the tape-edges and selvage threads of the cloth.

The tape-edges and the outer selvage threads are operated by the spare rows of the jacquards ; some of these needles and hooks—in addition to

the 72 mentioned specifically in this case—are usually utilised for the above-mentioned satin strips.

$$\frac{6868 \text{ threads}}{72 \text{ in. finished cloth}} = 95 \text{ to } 96 \text{ threads per inch in the cloth.}$$

The number of cards can be calculated from the design in Fig. 37 by comparing the lengths of the parts G, H, and G, with B, A, or C: each of the latter represents, in this example, 600 vertical rows of small squares. (These vertical rows of small squares are often called " cords " by designers.) Each part B, A, or C measures 43 units (millimetres in photograph), and part G measures 57 units. Therefore, since the design-paper was 12-by-12, it follows that

$$\frac{600 \times 57}{43} = 800 \text{ cards approximately for G};$$

while part H, being 104 units in length, should contain approximately

$$\frac{600 \times 104}{43} = 1451, \text{ say } 1450 \text{ cards.}$$

The cards for part G would be used twice in each cloth as explained; hence the number of picks of weft in the figured portion of the cloth is

$$(800 + 1450 + 800)\ 3 \text{ picks per card} = 9150;$$

and, since this section of the cloth occupies 66 in., it will be seen that there are

$$\frac{9150 \text{ picks}}{66 \text{ in.}} = 138 \text{ picks (approximately) per inch in the finished cloth.}$$

A number of uncut cards would be used to weave the required length of simple " satin " between successive figured portions, this length being utilised for the end of one cloth, the beginning of the next, and the part allowed for hemming both ends after the cloths are separated. See Fig. 38.

The allocation of the number of needles for the single and the double parts can be made by a similar calculation. Thus, in Fig. 37 we have

Distance from edge of figure to end of single part . .	= 124 units
Width of single part	= 30 „

And, since the double and single parts combined contain $1800 - 72 = 1728$ needles, we have

$$1728 \times \frac{30}{124} = 418, \text{ say } 420 \text{ needles,}$$

because

$$\frac{420 \text{ needles}}{12 \text{ needles per row}} = 35 \text{ complete rows for single part.}$$

And this is the arrangement shown in Fig. 42, the upper part of which is exhibited below in a different manner:

Machine B.	Machine A.	Machine C.
600.	72 + 528.	180 + 420.
Double part for ornament and satin strips.		Single part.

In order to demonstrate the difficulties which would be encountered in arranging a harness mount to produce an absolutely perfect representation of all parts of the ornament on the cloth, and to compare the various methods explained in the foregoing discussion, we append particulars of the number of jacquard machines, needles, hooks, and cards required for the four distinct ways of mounting and weaving.

Harness Mount and Type of Weaving	No. of Machines 600's.	Needles.	Hooks.	Cards for Figure Portion only.
By actual method adopted in common harness	3	1800	3600	2250 for each machine, or 6750 in all.
For perfect reproduction in common harness	5	3000	6000	3050 for each machine, or 15,250 in all.
For similar effect to Fig. 37 in full harness	6	3600	3600	6750 for each machine, or 40,500 in all.
For perfect reproduction in full harness	10	6000	6000	9150 for each machine, or 91,500 in all.

If there are 14 cards per pound for the 600's machines, ordinary pitch, it is evident that the weight of cards for the latter method would be

$$\frac{91,500}{14} = 6536 \text{ lbs., or nearly 3 tons,}$$

and the cost, say only at 4d. per pound, amounts to

$$\frac{6536 \times 4}{240} = \text{nearly £109.}$$

The reason for the word "impracticable," apart altogether from the consideration of the mounting of the machines and harness, is therefore quite apparent. The designs illustrated in Figs. 39 and 41 are intended to be woven by the aid of three 600's twilling jacquard machines, and Fig. 43 illustrates a weaver at work with a loom mounted with three such machines and weaving a fine wide linen damask. It will be observed that the three distinct sets of cards (one set for each machine) occupy a position at the front of the loom and over the weaver's head. In Fig. 44, however,

which illustrates a somewhat similar three-machine loom, the cards are at the back of the loom and above the warp threads. We shall have occasion to refer later to these two methods of accommodating the cards, and to deal exhaustively with them.

FIG. 43.

As a final illustration referring to this particular class of work, we introduce Fig. 45, which is a view of the back of a wide loom mounted with four 600's twilling jacquard machines. Altogether there are 4800 hooks employed, and the illustration shows very well the directions which several

of the harness cords take from several of these hooks to the harness reed

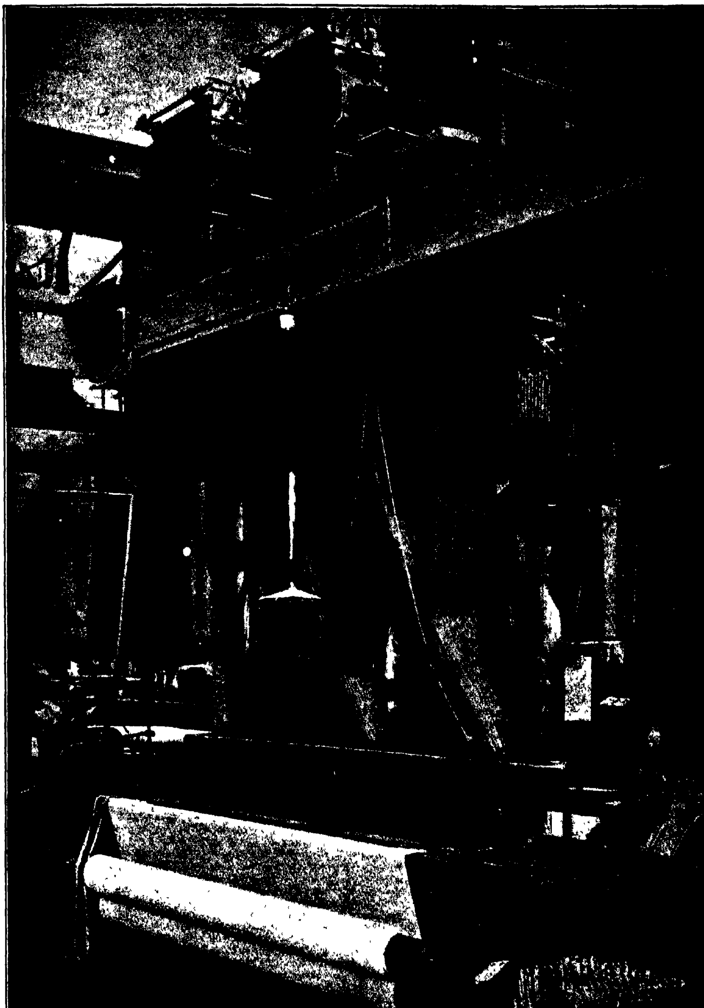


FIG. 44.

or comberboard, and their vertical direction from the latter to the mails through which the warp threads pass on their way to the cloth.

We have already stated that the simplest conditions obtain in the

harness mounting when the number of hooks and needles used for the development of any particular portion of a design is a multiple not only of the number of short rows in the jacquard, but also of the number of threads in the weave which it is intended to use. This does not imply that it is

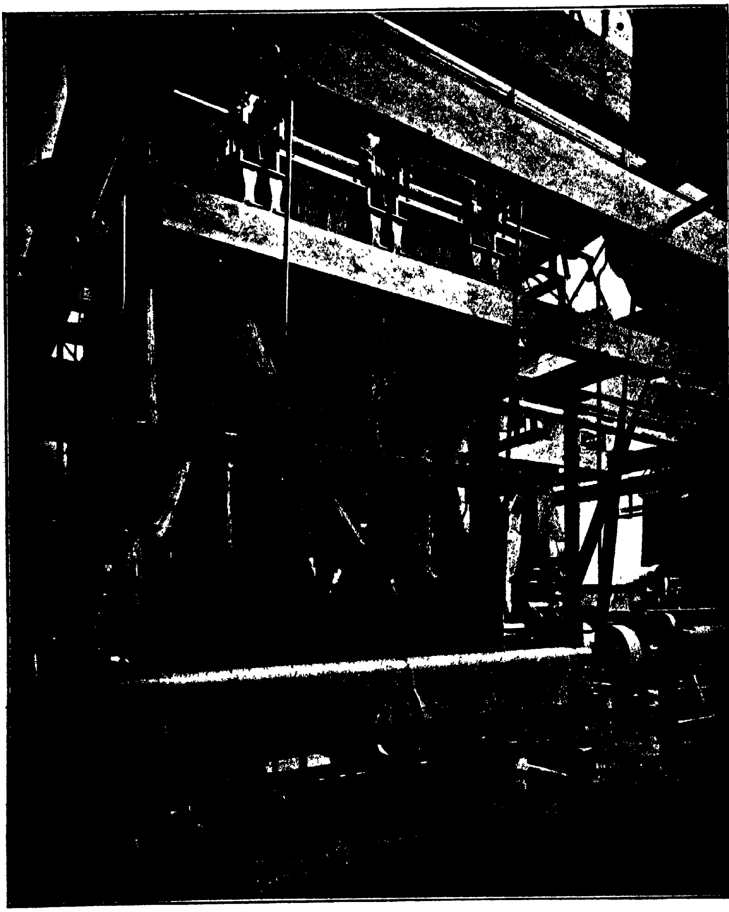


FIG. 45.

impossible for other numbers to obtain; as a matter of fact, many different values are used, each of which involves the use of a certain number of complete rows plus a part of a row. It is a more common practice to use a number of needles and hooks which is not a multiple of the number of hooks in a short row of the jacquard, than it is to use a number which is

not a multiple of the number of threads in the weave, and occasionally a number of hooks is used which is neither a multiple of the weave nor of the number of hooks in a short row.

In very fine work the addition of one or two squares in the length of the float is comparatively unimportant, but in coarser goods the same addition to the normal length of float may prove disastrous. Except under very special circumstances, the twill in one side border is opposite in direction to the same twill in the opposite side border, while in many fabrics the direction of the twill is reversed in other parts of the cloth—parts in which this alteration in the direction of the weave appears more pronounced, and is thus calculated to injure the appearance of the fabric more than when confined solely to the borders. When such conditions obtain it is possible slightly to minimise the defect by paying attention to the way in which the oppositely directed twills join. In order to emphasise this fact we have prepared Fig. 46, which represents in the solid portions in the two outer blocks of each design the ordinary eight-thread sateen weave, starting in each case on the same thread; the middle blocks, shown in crosses, are composed of the same weave, but in each of the eight designs the centre weave commences on a different thread, and of course twills in the opposite direction to that shown in solid marks. The maximum float or floats will be found between two dissimilar marks. By inspection we find the following:

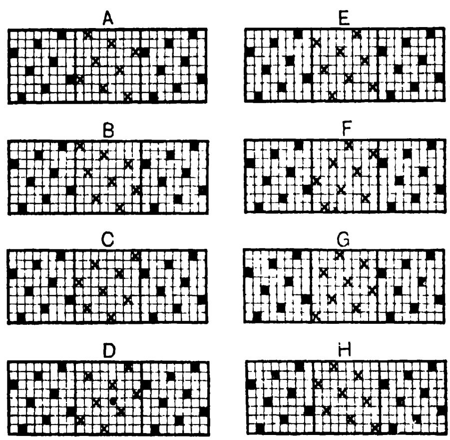


FIG. 46.

Design Letter.	Weave in Solids commences on	Weave in Crosses commences on	Maximum Length of Float.	Pick Nos. which contain Max. Float.
A	1st thread	1st thread	14	3 and 6
B	,,	2nd ,,	13	6 ,, 8
C	,,	3rd ,,	12	5 ,, 6
D	,,	4th ,,	11	2 ,, 6
E	,,	5th ,,	10	2 ,, 6
F	,,	6th ,,	11	3 ,, 7
G	,,	7th ,,	12	3 ,, 4
H	,,	8th ,,	13	1 ,, 3

If, therefore, the choice of the least imperfect joining involve no serious difficulties in the mounting and in subsequent work, it is certainly an advantage to consider this particular phase of the question. Although a haphazard joining is scarcely perceptible in fine work, we prefer to illustrate the method of choosing the best point in connection with a mounting which is intended for such work—the principle being, of course, applicable more or less to all setts. Before doing this, however, we propose to illustrate one or two points which bear not only upon this question, but upon the method of duplication. The great advantage which accompanies the centre-tie or doubling of the harness is that of keeping the number of needles at a minimum, and consequently of obtaining the desired pattern with a com-

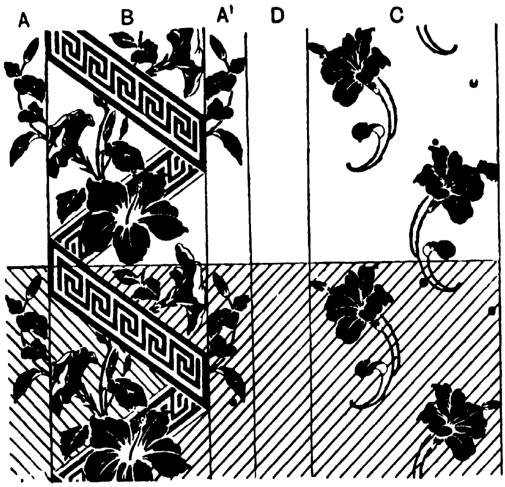


FIG. 47.

paratively small outlay in the cost of cards. Otherwise, all such duplication affects in a greater or less degree the beauty of the fabric, and to obtain the nearest approach to perfection in the joining, or in a subtle manner partially to hide the joining, is one of the aims of the designer, and often demands considerable skill.

Fig. 47 shows practically two repeats in the way of the weft, as well as complete units of the border and filling of a geometrical and floral design for full-harness weaving. The two parts marked A and A^1 are operated from the same hooks and needles; but one part, A^1, is doubled over in the harness in the usual way to form a centre-tie on a small number of hooks; part B is the central or main portion of the border; C is the filling or repeat; while D is a strip of simple satin inserted between the two chief portions of

the design. The geometrical or key pattern is almost continuous, and thus effectively separates the two triangular parts of each repeat of the border. Whenever such conditions obtain—that is, whenever the figured portion of the border is unbroken—the ground twills may be satisfactorily inserted as indicated by the diagonal lines in the lower half of the design. In this way all the ground part of the border on the right of the key pattern, as well as the simple satin stripes and the ground of the repeat portions, may be developed with a twill running to the right. The doubled-over portion on the left, marked A, naturally twills in the opposite direction, to the left, and the remainder of the ground on the left of the key pattern must also twill to left. The right-hand twill should, of course, join perfectly at the vertical lines between B and A^1, between A^1 and D, and also between D and C; but it may proceed towards the key pattern without regard to the method of joining up to the central part of the border. From the very nature of the tie it will be evident that the twill in the left-hand border will be oppositely directed to that in the corresponding part of the right-hand border, and there is bound to be a fault somewhere near the latter border. The break or joining part in this case may be made between the last thread of the last repeat and the first thread of the simple satin stripe, or between the last thread of the simple satin and the first thread (left-hand thread) of the right border. The latter method would probably be the better, and if adopted the two simple satin portions would be tied up in the straight-through repeating order. Let us suppose that two 600's machines are desirable for the successful development of the above design. The widths of the various sections show that the following arrangement would be satisfactory:

1st Machine, for Borders.	2nd Machine, for the Repeating Part and the Simple Satin Parts.
2 hooks idle.	12 hooks idle.
2 ,, plain.	24 ,, for simple satin parts.
8 ,, twill.	576 ,, for repeat.
132 ,, double for outside borders.	
468 ,, single for central parts of borders.	
612	612

Each simple satin portion D would contain about 180 threads, but if both stripes are made to occupy identically the same number—and this almost invariably happens—it will be found that the joining near the right border will be imperfect, and indeed identical with the arrangement shown at A, Fig. 46. If, however, 184 cords—*i.e.* $184 \div 8 = 23$ repeats of the

weave—be tied up for the left-hand stripe, and 180 cords, or $180 \div 8 = 22$ repeats plus 4 cords, be tied up for the right-hand stripe, the joining will be

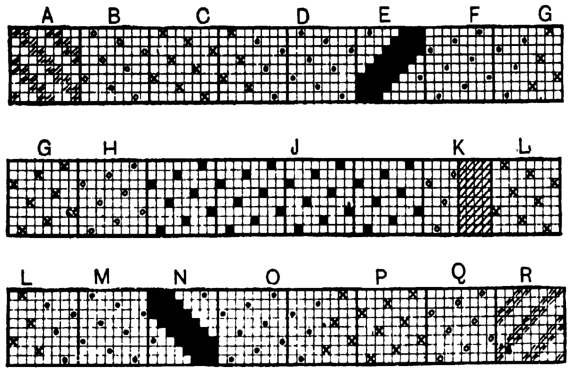


FIG. 48.

more perfect. Figs. 48 and 49 have been prepared to show how the various sections will join if the following order is adopted :

40	threads for	tape, selvages, etc.,	marked	A and B	(16	shown)
132	,,	outside border	,,	C	12	,,
468	,,	inside ,,	,,	D E F	32	,,
132	,,	outside ,,	,,	G	12	,,
184	,,	simple satin	,,	H	8	,,
3456	,,	six repeats	,,	J	32	,,
180	,,	simple satin	,,	K	4	,,
132	,,	outside border	,,	L	12	,,
468	,,	inside ,,	,,	M N O	32	,,
132	,,	outside ,,	,,	P	12	,,
40	,,	tape, selvages, etc.	,,	Q and R	16	,,
5364						

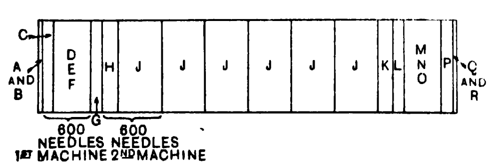


FIG. 49.

This number of threads for a damask $77\frac{1}{2}$ in. wide in the reed would require a 64 porter 2 per split, or between 69 and 70 threads per inch in the reed, and about 74 threads per inch finished.

Parts E and N in Fig. 48 are intended to represent the geometrical

pattern B in the border in Fig. 47, and the distinctive weave marks indicate where the various sections join so far as the weave is concerned—the blocks do not represent rows of the jacquard. The four shaded threads at K represent the ones which are omitted purposely to improve the effect at the joining between K and L; it will be seen that the longest float is 10, and the joining is relatively the same as that shown at E, Fig. 46.

If the cloth for Fig. 47 were required to be developed with 5-thread weaves, and according to the arrangement indicated with reference to Fig. 49, the following arrangement would be suitable:

2	threads	plain	A and B
16	„	twill	A and B
30	„	simple satin	A and B
130	„	outside border	C
470	„	inside „	D E F
130	„	outside „	G
180	„	simple satin	H
3450	„	six repeats of 575	J
182	„	simple satin	K
130	„	outside border	L
470	„	inside „	M N O
130	„	outside „	P
30	„	simple satin	Q and R
16	„	twill	Q and R
2	„	plain	Q and R
5368			

By introducing 182 threads instead of 180 in part K a better joining is effected between the simple satin stripe K and the outer border L, the maximum float being six.

Fig. 50 illustrates the mounting of the jacquards for the design shown in Fig. 47. Each section is lettered immediately below the comberboard or harness reed to correspond with the similar sections in Fig. 49, and the first and last harness cords only in each section have been drawn between the neck cords and the comberboard. The harness cords for the plain and twilled threads of each selvage are not shown in the drawing, but these may be tied up to the last ten hooks of the first row of the jacquard on the left of Fig. 50 and as indicated in the particulars referring to the allocation of the hooks in the first machine, or, if desirable, the first machine may control the harness cords for the left-hand selvage, and the last ten hooks of the first row or the last ten hooks of the last row of the second machine may control the harness cords for the plain and twilled threads in the right-hand selvage. The whole of the simple satin in parts B, H, K, and Q is controlled by the two rows of 24 hooks in the second machine; the use of two full rows, or three repeats of the weave, obviates the necessity

for cramming the harness reed or the comberboard at these portions, but it naturally diminishes the figuring capacity of the machine, which is used,

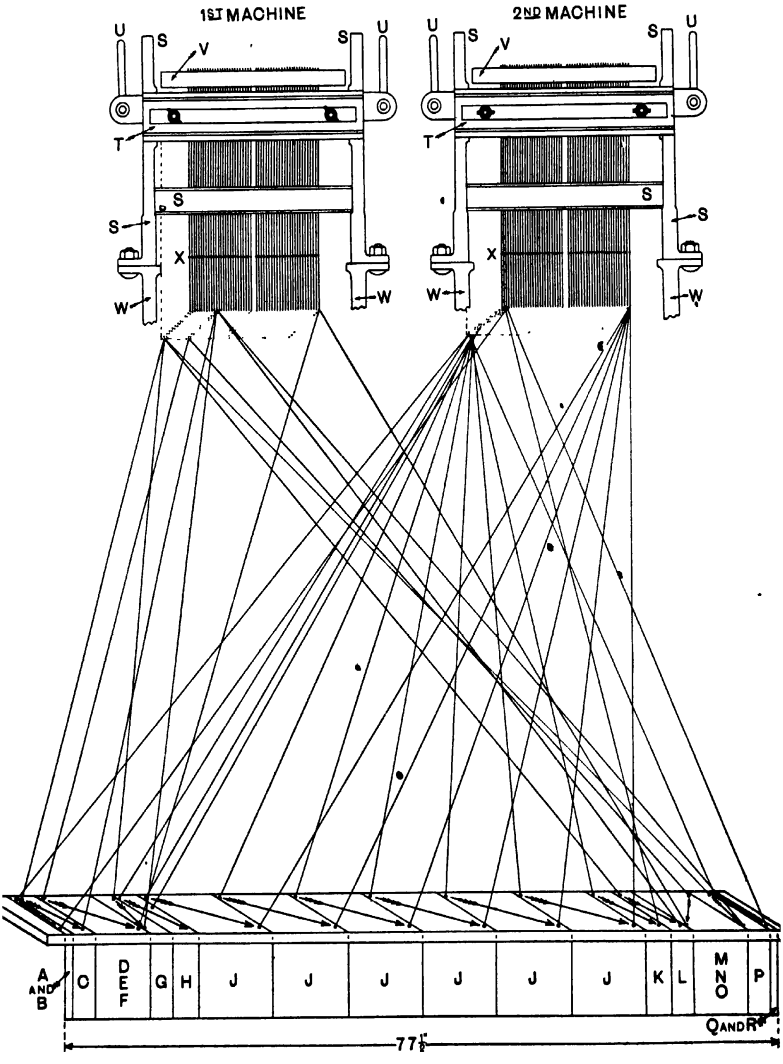


FIG. 50.

in this case, for the development of the filling or repeating part of the design. In Fig. 50 we have inserted the framework of both jacquards in

order to show the relative positions of the various parts. Although the tie-up is for a full harness, we have introduced the back framework of twilling jacquards: this for two reasons—first, because it shows the maximum width required for two 600's machines with 3 in. between them; and second, because most ordinary 600's machines are only about 4 in. narrower than the twilling jacquards, while some ordinary machines, especially those with swinging cylinders, occupy approximately the same width as those illustrated. It will be seen that S is the framework at the back of the machine, or front of the loom in this case, T the spring-boxes, U the swan-necks, V the griffes or knives, and W the stools which support the jacquards, and which are themselves supported by long girders not shown. The bottoms of the hooks are at X; from this point to the point of connection with the harness cords represents the neck-cords, near the ends of which is situated the heck-box.

The complete border design, as well as the complete unit of the repeating part of the design, appears in the upper portion of Fig. 47, but, although this represents more than is actually required by the draughtsman who transfers the sketch to point-paper, it is usual to make at least one and a half repeats in the way of the weft of the complete border, and also a similar proportion of repeats of the filling in the way of the warp and of the weft. Such an arrangement enables one better to judge the merits and defects of a design, and for this reason sketches for textile work are often displayed as illustrated in Fig. 51. This design is of the same nature as the one which has just been considered—*i.e.* the two outer portions of the border are obtained by doubling the harness, the central part of the border by a straight-through tie, and the filling by repeating the unit as many times as it is necessary to make up the desired width of cloth. The dimensions of this design are as follows:

$$\left.\begin{array}{ll}\text{Left-hand outer border} \quad . \quad . \quad . & 2\tfrac{3}{16} \text{ in.}\\ \text{Inner border} \quad . \quad . \quad . \quad . \quad . \quad . & 5\tfrac{13}{16} \text{ ,,}\\ \text{Right-hand outer border} \quad . \quad . \quad . & 2\tfrac{3}{16} \text{ ,,}\end{array}\right\} 10\tfrac{3}{16} \text{ in.}$$

Filling or repeat . . . . . 8 ,,

If two machines were utilised for this cloth, one for the border and one for the filling, each straight part of the design—*i.e.* without doubling—would require 75 hooks per inch of pattern; thus

75 hooks or needles $\times 2\frac{3}{16}$ in. $= 164$ hooks for outer border,
75 ,, ,, $\times 5\frac{13}{16}$ in. $= 436$,, inner ,,

600 hooks.

75 hooks or needles $\times$ 8 in. = 600 hooks for repeat.

If desired, the same method of twilling as that described in connection

with Fig. 47 may be employed, since the central ornament of the border design is continuous. It is very often a difficult matter to make a satisfactory joining between two borders and the repeating pattern, if one

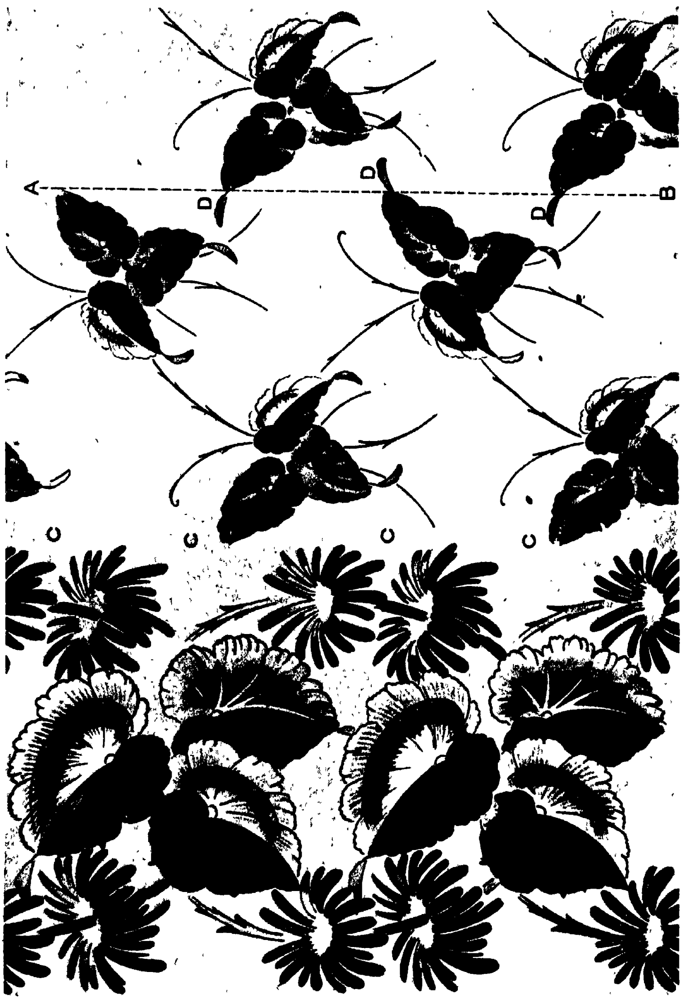


FIG. 51.

figure overlaps the other as is the case in Fig. 51. When, however, the various figures in the repeat do not overlap, little or no difficulty is experienced with regard to the floral sections, and the only defect may be that

caused by the unsatisfactory joining of the twills as emphasised with respect to Figs. 47, 48, and 49. The complete ornament in the repeat portion of the design in Fig. 51 includes a small turnover of all three leaves, and one of these turnover parts in each figure overlaps as shown where the dotted vertical line AB cuts the points. Now, it is quite evident that if the two extreme edges of the repeat or filling finished with the tips of these leaves, we should have alternate and almost complete figures in the way of the weft joining up to the border on both sides; but we should also have the tips of the next vertical row of figures joining up to the border. These tips have been omitted near the border in the design, but on the left-side border they would appear at points C. The omission of the tips would simplify the subsequent operations considerably, although it may detract from the beauty of the ornament. If the tips D were left out, the complete design would be identical with that on the left of the vertical line AB, except for the two tips which appear at present on the left of this dotted line.

A slight modification is possible without seriously affecting the tie-up —namely, by leaving out the tips in one horizontal row and retaining them in the other, a method which would still allow the figures to overlap in the main portions of the filling. Thus, if the tips on the left of the figures in the odd horizontal rows were omitted, the repeating design would join up to the left-hand border exactly as illustrated. The tips on the right of the figures in the even horizontal rows would remain, and would appear in all the figures in those rows except in those which formed the last vertical row joining up to the right-hand border. In order to make this joining correspond with the almost perfect joining on the left, it would be necessary to omit the harness cords in the last repeat in that part which develops the tips—*i.e.* for about three-quarters of an inch in the 8-in. repeat, or $75 \times \frac{3}{4}$ in. $= 56$ cords, or 7 repeats of the weave.

The complete figures could be retained, if desired, on both sides, but only by the addition of 112 cords to the border parts, 56 of these to be utilised for the special purpose of operating the extreme narrow section adjoining the left border, where the tips, which would otherwise appear at C, would be omitted from the design, and the remaining 56 cords for operating a similar number of threads on the right; it would also be necessary, when tying up for the repeats, to omit a corresponding number of harness cords at the beginning of the first repeat, and a similar number at the end of the last repeat to make up for those which are introduced specially for the purpose of securing a perfect design on the cloth. It need hardly be mentioned that provisions of this kind involve more labour, more hooks, more designing, and more care than are required for the reproduction of practically the same design in which the joinings are not so carefully considered. It is only on special occasions that precautions are taken to

eliminate these incomplete portions of a figure from the first and last repeats of the filling design.

The method of producing borders by doubling over a certain number of harness cords, and retaining a larger number of cords for a straight tie, as exemplified in the last two examples, is a favourite one in several branches of the textile industry, and it is certain that such a procedure enables the designer to make good use of the number of hooks and needles at his disposal with almost negligible defects in the resulting fabric. The economic utilisation of the hooks and needles may be carried still further, and, although for obvious reasons one can never expect to employ the great variety which obtains in connection with shaft or leaf work, there is considerable scope for ornamentation without increasing sensibly the number of needles at one's command. Take, for example, the design and tie-up illustrated in Fig. 52, an example of what is technically known as a "lift-in" pattern, because the central part C of the outer or wider border is, as it were, lifted in, or at least reproduced, to form the inner border F. The narrow extreme part B is doubled over to form part D; then the whole, except the simple satin part E, is doubled over to obtain the complete combined border H, K, L, and M on the right. The simple satin part E is operated from the second machine on the left, while the simple satin part J is operated from the first machine. A and N naturally represent the selvages and the narrow strips near the selvages, only the sateen parts of which are shown in the tie-up; part N is often developed by hooks on the right hand of the first machine instead of by hooks on the left, as illustrated. The filling is represented by two repeats G only, although more repeats may be necessary according to the type and width of cloth which it is intended to produce with this ornamentation developed on it—in the case under notice six repeats would be essential. Such designs as this are often intended for table decoration, and the cloths are so constructed that the central part from about the middle of E to the middle of J lies upon the table, while the remainder hangs over the sides.

The positions of the machines differ from the preceding example, inasmuch as the border machine is in this case on the right; this is done, as previously mentioned in connection with three machines, to obtain the most satisfactory disposition of the cords with respect to the angles formed by the cords with the harness reed, and to keep most of the doubled-over portion clear of the repeating part. The proportions of the design, if arranged for two full-harness machines, as illustrated, require the following number of hooks for each:

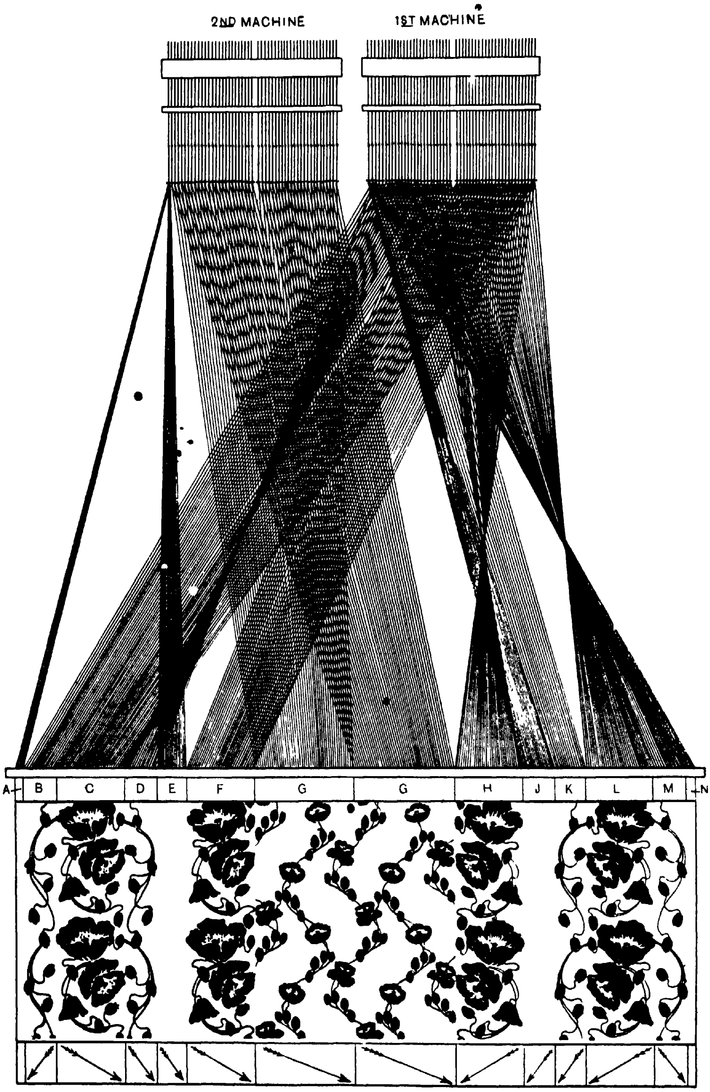


FIG. 52.

First Machine			Second Machine		
4	hooks	twill or tape.	4	hooks	twill or tape.
8	,,	simple satin.	8	,,	simple satin.
196	,,	double border.	600	,,	for 6 repeats (2 only shown).
404	,,	single border and lift-in.			
612			612		

196 ÷ 12 = 16 rows + 4 hooks for doubled-over part,
404 ÷ 12 = 33 ,, + 8 ,, single and lift-in,
600 ÷ 12 = 50 ,, for repeating portion.

In Fig. 52 the front rows in the harness reed in these portions are represented by 16, 34, and 50 cords respectively, while the warping arrangement for a finished cloth 72 in. wide is as follows :

	Marked.	Operated by Needles and Hooks.	Machine.
2 threads plain	..	Special needles	2
16 ,, twill	A	1 to 4	2
48 ,, simple satin	A	5 to 12	2
196 ,, double border	B	13 to 208	1
404 ,, single ,,	C	209 to 612	1
196 ,, double ,,	D	208 to 13	1
192 ,, simple satin	E	5 to 12	2
404 ,, lift-in	F	209 to 612	1
3600 ,, six repeats	G	13 to 612	2
404 ,, lift-in	H	612 to 209	1
192 ,, simple satin	J	5 to 12	1
196 ,, double border	K	13 to 208	1
404 ,, single ,,	L	612 to 209	1
196 ,, double ,,	M	208 to 13	1
48 ,, simple satin	N	12 to 5	1
16 ,, twill	N	4 to 1	1
2 ,, plain	..	Special needles	..
6516 threads	..	..	..

$$\frac{6516}{72} = 90\tfrac{1}{2} \text{ threads per inch finished ;}$$

and approximately

$$\frac{6516}{77} = 84\tfrac{1}{2} \text{ threads per inch in the reed}$$
$$= 52^3 \text{ porter reed.}$$

Following the plan adopted in Fig. 48 with regard to the joinings of the various parts in Fig. 47, we illustrate at Fig. 53 the similar plan for Fig. 52. Here, again, the letters correspond to similar parts in both. The first three rows of designs represent all the sections from selvage to selvage, the middle

row showing the six repeats G between the two parts F and H of the lift-in portions. The bottom row shows an alternative method for the repeating part. From A to the end of F, and from H to N, the maximum lengths of floats are:

10	between	sections	C	and	D
10	,,	,,	E	,,	F
14	,,	,,	F	,,	G
10	,,	,,	H	,,	J
10	,,	,,	K	,,	L
10	,,	,,	F^1	,,	G^1
11	,,	,,	G^1	,,	H^1

Hence, if the design for the repeating part—*i.e.* that for the second machine—be twilled as shown at G^1, a less defective joining would result; and

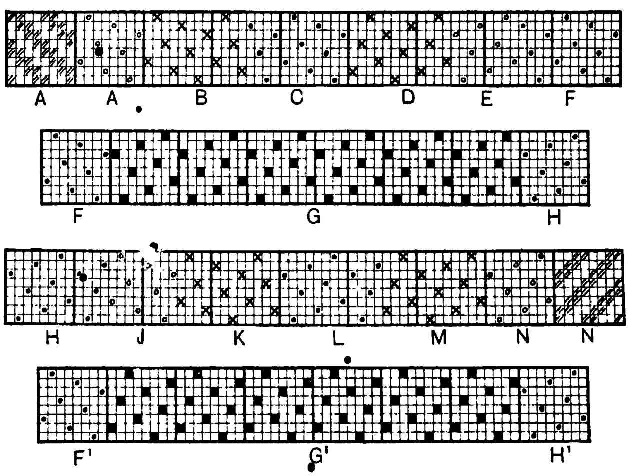


Fig. 53.

although this may not be the usual method of starting the weave, there appears no reason why it should not be adopted in certain cases if less imperfect junctions obtain. Although the principle suggested above would effect an improvement as compared with haphazard joinings, and may be necessary in comparatively coarse setts, it is often neglected in fine work, simply because a float of even 14 may not be unsightly. It is, of course, understood that 8-thread weaves are seldom used in coarse setts, the 5-thread weaves being almost invariably employed. The same principle, however, obtains; but we have not considered it necessary to introduce other examples. The maximum float in all similar cases will be found to be $2n-2$, where n is the number of threads in the unit weave.

The principle of improving the junction of the central part of a design and the right-hand border or doubled-over section of the harness is applicable without much additional trouble to all stripe designs which contain a comparatively large number of threads in the simple satin stripe. It may also be employed in connection with those full-harness designs which do not possess a satin stripe, but in these cases it is more difficult to arrange. and perhaps not worth the trouble, since the majority of these cloths are in fine setts where, as already stated, a float of 14 is not particularly objectionable. Suppose, however, it were necessary for some reason to keep the float at a minimum in such a design, the following would be one method of meeting the difficulty: If the design were made in the ordinary way, and four threads dropped at the junction, the effect would be equivalent to withdrawing the narrow stripe marked A in the simple sketch in Fig. 54, in which case there would obviously be an imperfection in the cloth.

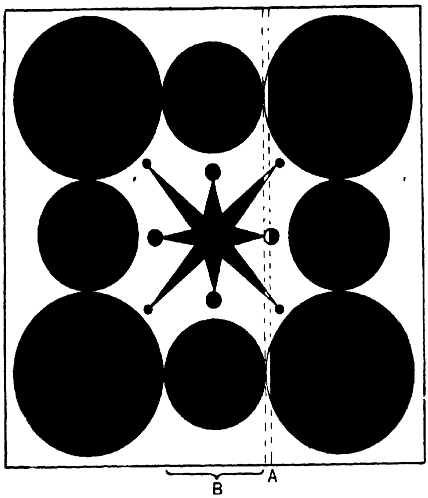


Fig. 54.

Circles have been drawn purposely to show up this defect clearly, for there is perhaps no kind of ornament which is more difficult to reproduce in cloth than that of a perfect circle. If, therefore, as mentioned, the 4 threads were dropped or omitted, as was found feasible in the satin stripes, it is evident that two of the large circles and a small circle of the right-hand border would present flat sides to the adjoining part of the design, and also that two tips of the star would be out of line with their stems. If, however, the small section at A be drawn and painted at the right-hand side of the central portion B, the joining of the weaves would present a

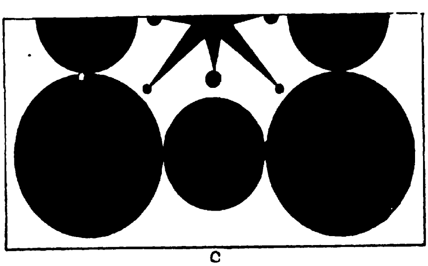


Fig. 55.

minimum float, and the pattern itself would be continuous and perfect except in so far as concerned irregularities which might occur in consequence of incorrect numbers of picks per inch with respect to the number of threads per inch. The perfect reproduction would then be as illustrated by the half-design in Fig. 55. Suppose, for example, that 1200 needles and hooks were utilised for a pattern of similar proportions to those illustrated in Fig. 54. We should have

720	needles for	borders,
480	,,	centre,

which would give

720	threads for	left-hand border,
480	,,	centre,
720	,,	right-hand border.
1920		

And the small part of the pattern which has been omitted from the right-hand border in consequence of dropping four cords from this section would have to be introduced on to the central design, in order to make the pattern continuous, as in Fig. 55, and thus use the same number of threads.

Another, and certainly simpler, method of arriving at a similar result would be to double all the 720 threads over to the right, and then make the central design on 476 needles or 484 needles, and in both cases a minimum float would be obtained.

Although such a method is practicable and applied without much difficulty to patterns in which the central part is not repeated, it is scarcely practicable in those designs where two or more repeats of the filling are required, unless the design is of a nature somewhat similar to that illustrated in Fig. 51; but in all such cases as the latter the result would scarcely justify the means employed to secure it.

For twilling jacquard work the same number of threads would have to be dropped, but the number of needles involved would naturally depend upon the number of hooks which each needle controlled. Thus, if each needle controlled two hooks, and the weave was the 8-thread sateen, two needles more or less than some multiple of four would be a satisfactory number to use.

The upper part of Fig. 56 is a plan of the harness reed for the design illustrated in Fig. 52, while the lower part, which shows part of a table T, indicates where the different parts of the ornament would appear when the damask cloth in Fig. 52 was laid on the table. The chief defect in the arrangement of the threads in the harness reed is the fact that the large number of threads in the simple satin stripes F and J have to be crammed

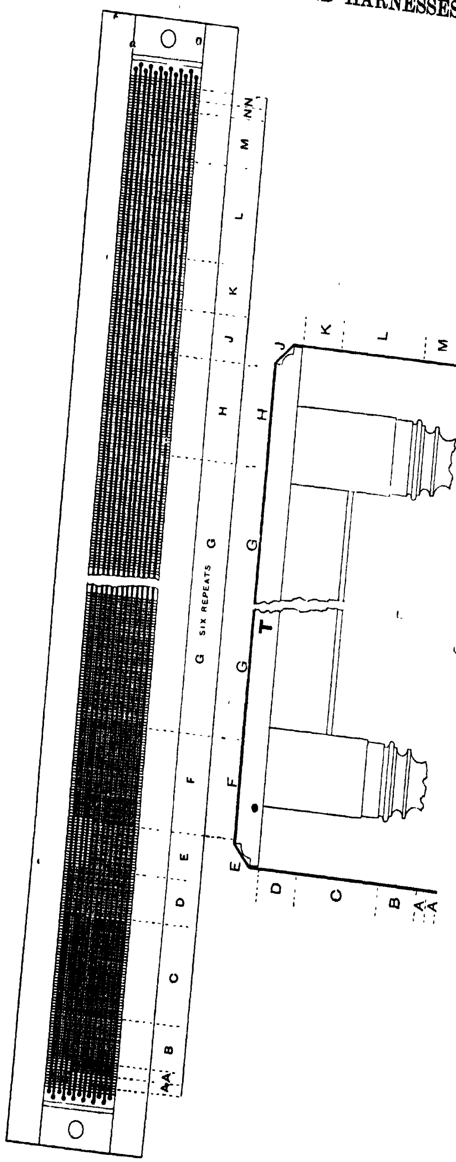


Fig. 56

into 8 rows of the harness reed on account of the employment of only 8 hooks for this portion. With the method of tying-up as illustrated, the defect is irremediable, but if all the plain and twill threads in both selvages be operated by special needles and hooks outside the control of the cards, as is often done, two rows of needles and hooks—the first row in both machines, or other suitable rows, that is, 24 hooks in all—could be used, in which case no cramming in the simple satin stripes would be necessary. It is evident, however, that there is an objectionable feature in both cases, and the choice of one or other method depends upon those in charge of the mounting. A much better method would naturally obtain if two rows from each machine could be employed for this purpose; with this arrangement the left-hand satin could be worked from one machine, and the right-hand satin from the other machine. And, if even only two rows from one of the machines be used for both stripes, there will be three repeats of the weave in the two rows. In the latter case the repeating pattern would probably be designed on 588 needles instead of on 600. The left-hand side of the harness reed in Fig. 56 is complete, but the right-hand side contains only the first and last cords in each section.

In all the cases illustrated, and in all similar cases, the only parts which need be transferred to the design-paper for the use of the card-cutter are complete units of the outer and inner borders for one machine, and one unit of the repeating part for the other, with, of course, corner-pieces and cross-borders if the cloth is intended to have a border on all sides.

Fig. 57, which is a similar design, and one in which complete units appear for the two machines, will illustrate this phase sufficiently. A is the outer border, B the inner border, and C is the repeating part. When the cloth is woven, part A will appear on both sides of B, but in reverse directions, A being doubled over, the three sections thus producing a complete border. The duplication of the whole of this border is essential for the border at the other side of the cloth. It will be noticed that the central portion B of this design is unsuitable for a "lift-in" such as is illustrated in Fig. 52, because the two tulips near the top of the design would be broken if this part were detached from the two outer sections A. When the two parts A and B have been transferred to point-paper, painted in, and the weaves introduced, the work is ready for the card-cutter. Part C is prepared in the same way on a separate sheet of design-paper, because it is to be cut on cards for the second machine.

The designs illustrated in Figs. 47, 51, 52, and 57 are all intended for full-harness work, where, for wide cloths in fine setts, it is necessary to introduce a number of repeats into the filling. When twilling jacquards are used, rarely less than double the width of pattern is obtained as compared with full or brocade harness for a given number of needles. For cloths of

this type (see Fig. 37) the combined borders invariably occupy a greater width than the centre or filling of the cloth, and nearly all the wide figures in fine setts are woven by the aid of these jacquards. Consider, for example, the artistic heraldic design illustrated in Fig. 58. This was designed by Mr. Philip R. Paul, formerly of Dundee Technical College, and later of the Royal School of Art, South Kensington, and is intended for a table napkin. To weave this in a reasonably fine sett, say from 76 to 80 threads per inch finished and 27 in. wide, would require in the full or brocade harness jacquard about 1050 needles and hooks, or approximately two 600's machines, and this for a comparatively narrow fabric. And to reproduce this pattern successfully it is essential that the full-harness method of weav-

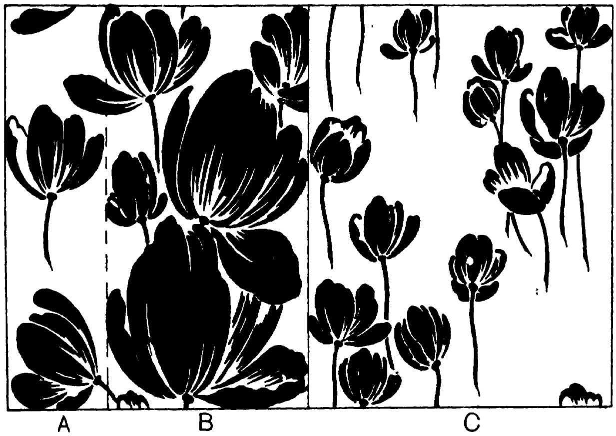


FIG. 57.

ing should be used, for the straight-lined ornament which adds so much beauty and contrast to the other elegant parts of the design can be reproduced only, with any degree of success, by this method. We have already come across difficulties in the joining of weaves even in the full harness, but the difficulties to be met in the reproduction of such line work are increased considerably and are really insurmountable in the method of weaving which is common to all twilling jacquards. The dark, light, and grey portions of the armoured knight and his steed and pennant, as well as the motto, "Absque labore nihil," can be successfully reproduced by the twilling jacquard, and, if the border were any form of ornament other than that of horizontal and vertical lines, the whole pattern could be woven with one 600's twilling jacquard, with two hooks per needle arranged as follows:

72 needles idle.					
480	„	double, operating	960 hooks	= 1920	threads.
60	„	single, „	120 „	= 120	„
				2040	threads.

Or, as arranged in a previous example of this work (see Fig. 29), make the single portion a little wider so that it could be utilised not only for the design

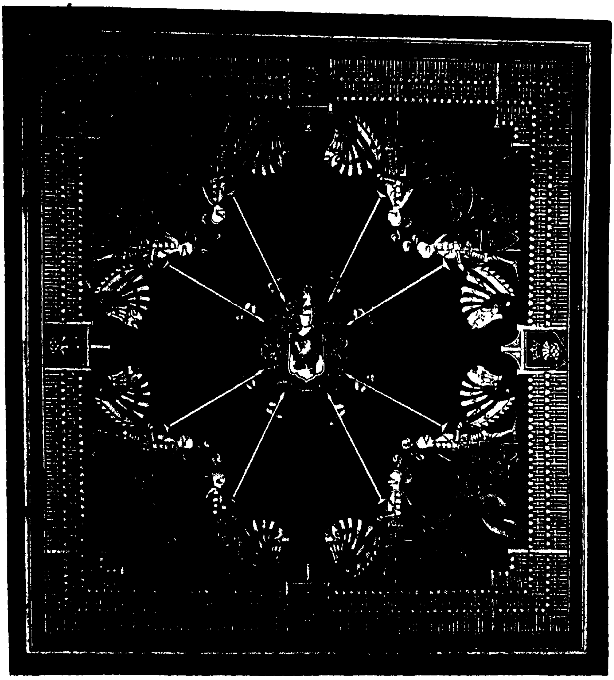


FIG. 58.

under notice, but also for others where the extreme central figure happened to be larger. Indeed, it is an excellent plan to utilise all the needles in the machine by leaving the maximum number of hooks for the comparatively narrow unsymmetrical part, and employing fewer hooks and needles for the doubled-over portion. Thus, in those similar designs which are illustrated in Figs. 26 and 28, 360 needles are used for the double portion and 240 needles for the single portion, giving approximately the same number of threads and sett, with no increase in the number and size of the card. The advantage of employing one machine instead of two is small compared with

the advantage obtained with respect to the cost in cards. If the design paper be 12-by-16, and two picks inserted for each card, the total number of cards will be

$$\frac{480 \text{ needles} \times 16}{12} = 640 \text{ cards to work forward and backward for the symmetrical part,}$$

$$\text{and } \frac{60 \text{ needles} \times 16}{12} = 80 \text{ cards to work forward only for the unsymmetrical part,}$$

720 cards irrespective of those required for that part which is to be hemmed.

720 cards at 14 cards per pound and 4d. per pound

$$= \frac{720 \times 4}{14 \text{ per pound}} = 206 \text{ pence nearly;}$$

whilst the corresponding values for the full harness would be four times as much: thus

$$\frac{960 \text{ needles and hooks} \times 16}{12} = 1280 \text{ cards for each machine to work forward and backward for the symmetrical part,}$$

$$\frac{120 \text{ needles and hooks} \times 16}{12} = 160 \text{ cards for each machine to work forward only for the unsymmetrical part,}$$

1440

—*i.e.* 1440 cards for each machine, or 2880 cards in all.

$$\frac{2880 \times 4}{14 \text{ per pound}} = 823 \text{ pence nearly.}$$

In addition to the extra attention demanded, and to the extra expense in cards and one extra machine, there is at least four times the expense incurred in transferring the sketch to point-paper. It is for these important reasons that twilling jacquards, in spite of their defects, are used for weaving those cloths upon which elaborate designs are developed.

Designs such as those already dealt with, elaborate though they be, require only what may be considered as comparatively simple methods of harness ties, involving as they do the simple repeating tie, the centre-tie, or a more or less extended combination of the two. Except in special cases, and then only for very narrow portions, the sett of the fabric is the same throughout, and the threads in the fabric, as well as the vertical rows of small blocks on the design-paper, form successively a perfect continuation of the design. This is typical of practically all damasks—silk, wool, cotton, linen, and jute—and of nearly all kinds of fabrics in which a single series of threads forms both the ground and the figure of the texture. And, under certain conditions, the production of many types of tapestries and other

decorative fabrics may proceed according to an arrangement based on somewhat similar lines.

Consider, for example, Fig. 59, which is a photographical reproduction of a fancy tapestry fabric developed by several colours of warp yarn. This fabric may be woven in a loom provided with one jacquard and mounted with a simple repeating tie. The full width of the pattern is $8\frac{3}{8}$ in., and as there are 160 threads per inch, it follows that 1340 hooks and needles, independent of those required for the selvages, will be necessary. Sections A and B are formed with one series of warp threads, but of different colours, whereas sections C and D are formed by two distinct series of warp threads—one series being utilised for the ground and the other series for the floral, curved, and straight-lined parts which are developed with diverse coloured warp yarns on the plain ground. The ground part in sections C and D, however, contains only $53\frac{1}{3}$ threads per inch, the remainder, or $107\frac{2}{3}$ threads per inch, appearing as extra warp threads, as shown by Fig. 60, which represents the back of the fabric. Now, although this cloth may be reproduced in the loom arranged with an ordinary repeating tie, it is evident that with this arrangement some difficulties would be met in the preparation of the point-paper design—difficulties which have already been discussed in Chapter II.

Parts A are developed with the 8-thread sateen in single warp and triple weft as illustrated at G, Fig. 61; hence, if some arrangement could be found to operate these threads independently of the jacquard, a considerable saving in the number of hooks, needles, and cards would be effected. These parts A, Fig. 59, occupy $2\frac{7}{8}$ in. of the pattern, and require 460 threads; therefore, if this number be deducted from the total number of threads in the pattern, it will be found that an 880's jacquard would be ample: $1340 - 460 = 880$ needles and hooks.

Somewhat similar conditions obtain in the pattern illustrated in Fig. 62, which represents another multi-coloured and extra-warp tapestry. Although this pattern is not so elaborate as that shown in Figs. 59 and 60, its production would probably involve more trouble, unless the cloth were woven with a simple repeating tie. The total width of the pattern in the cloth illustrated in Fig. 62 is $6\frac{9}{32}$ in., and the various parts indicated by letters immediately under the design are made up for one repeat as shown in the table on page 94.

[TABLE

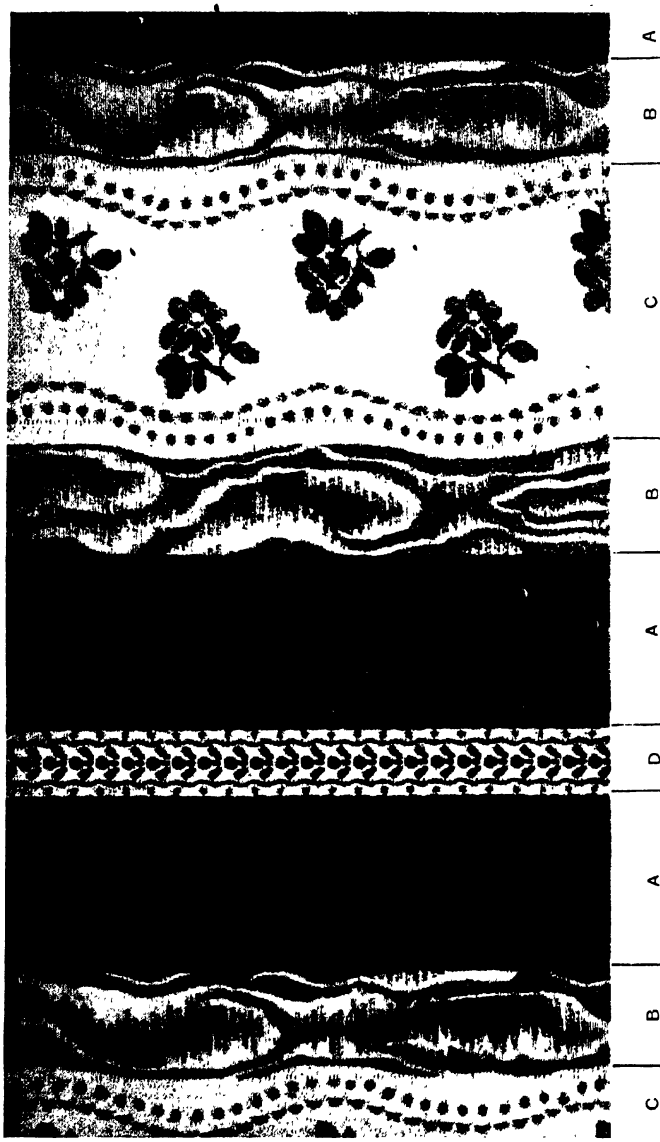


Fig. 59.

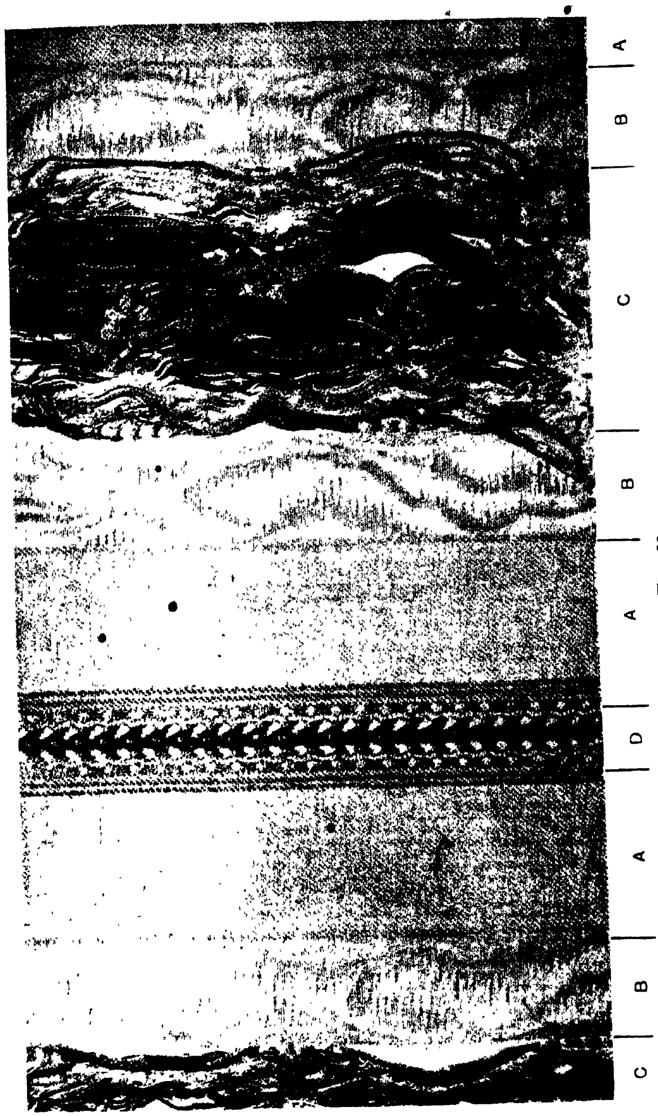


FIG. 60.

Parts.	Units of $\frac{1}{32}$ of an Inch.	Sateen Weave: Number of Threads.	Figure Weave: Number of Threads.
A	7	42	
B	23		140
A	7	42	
C	5		30
A	14	84	
D	5		30
A	28	168	
E	12		60
A	11	66	
F	14		84
A	11	66	
E	12		60
A	28	168	
D	5		30
A	14	84	
C	5		30
	32) 201	720	464
	$6\frac{9}{32}$ in.	1184 threads.	

It will thus be seen that out of a total of 1184 threads in each repeat there are no fewer than 720 which are developed in the simple 5-thread weave, double warp, double weft, illustrated at J, Fig. 61. The remainder of the ground weave, except that immediately under the floral portions, is developed in the rib weave shown at H, with two double threads and one double thread alternately. Apart from the above 720 threads of sateen, there are 464 figuring threads. Even if these threads were controlled independently of the jacquard, there are too many for a 400's machine with a straight tie, but they could easily be operated by a 500's machine. The two parts marked E are, however, symmetrical, and since each part contains 60 threads, it follows that if these two sections were operated by the same hooks with a centre-tie we should require only 464 − 60 = 404 hooks and needles, or an ordinary 400's jacquard. It is nevertheless quite apparent that unless these styles were typical of a number of others with the same proportions, the separation of the plain and fancy figuring threads, as indicated, would not conduce to economy.

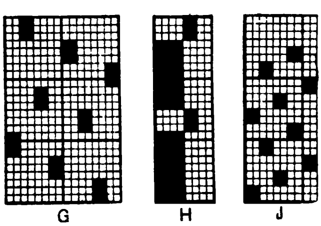


FIG. 61.

The separation of two or more series of threads for the purpose of employing a minimum number of needles, hooks, and cards naturally involves more complications in the operations of mounting and weaving, no matter what method is resorted to. Such a procedure very often, but not always, simplifies the method of card-cutting; and since the operation

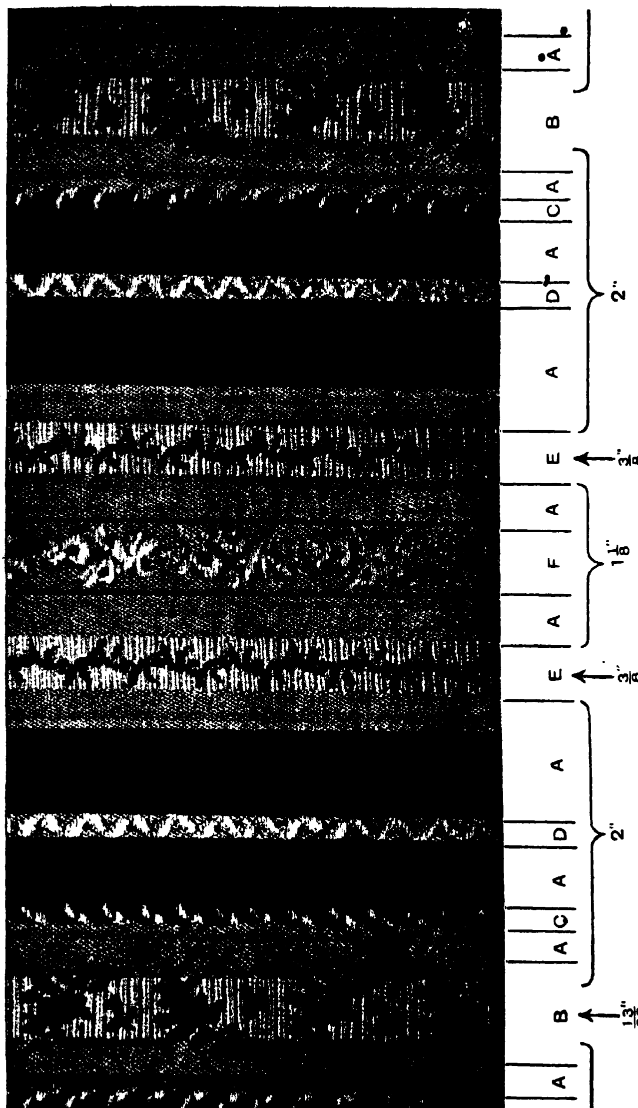


FIG. 62.

of preparing the cards is very similar for practically all the ordinary kinds of fabrics, we propose to deal with this branch at once.

CHAPTER IV

THE PREPARATION OF JACQUARD CARDS BY HAND-PLATES AND BY ORDINARY PIANO CARD-CUTTING MACHINES

THE preparation of jacquard cards for the loom may be a comparatively simple process, or it may be a more or less complicated process, depending, as it does, upon the size or pitch of the jacquard machine, the number of machines in use upon one loom, the character of the design, and the machine or apparatus in which or by which the cards are cut. In all cases the process consists of cutting or punching holes into certain parts of the card, and leaving the remainder uncut, so that when the card operates upon the needles of the jacquard, they may, through the medium of the hooks, cords, mails, and lingoes, result in the formation of two layers of threads to form the shed.

When complicated and large designs are required, and when several sets of cards from the same design have to be prepared for a number of looms, it is natural to expect that the mechanism will be much more extensive than what is required for the production of cards intended for actuating the needles of a small jacquard and for the development of simple designs on the fabric. For the latter type, and particularly if a very small number of jacquards are installed, a simple cutting plate, or hand-plate, may serve the purpose, although the process of preparing cards by the aid of such a plate is very slow.

Figs. 63, 64, 65, and 66 illustrate two simple hand-punching plates. Fig. 63 is a front elevation, Fig. 64 is a sectional front elevation, and Fig. 65 is a plan of one type of hand-plate, while Fig. 66 is an elevation of another type. Fig. 63 shows that the card A is held between two steel plates B and C. The holes in both plates coincide with each other, and are identical with those shown in the plan view in Fig. 65. The dimensions of the card A are indicated in the latter figure by the dotted rectangle, and it will be seen that there are 26 complete rows of holes, 8 in each row, commencing at D and finishing at E, or *vice versa*, or 208 holes irrespective of the 6 holes in each extreme row marked F. The 208 holes indicate that this represents

the maximum number of needles; the largest jacquard machine for which this plate can be used is what is termed a 200's jacquard. The large holes

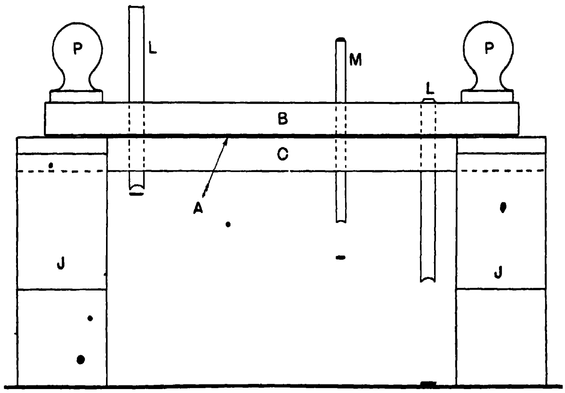


FIG. 63.

G are for the pegs of the card cylinder, the two extreme rows F of 6 each are for special work, to be utilised when necessary, while the four holes H, two near each end, are for the purpose of lacing the cards together.

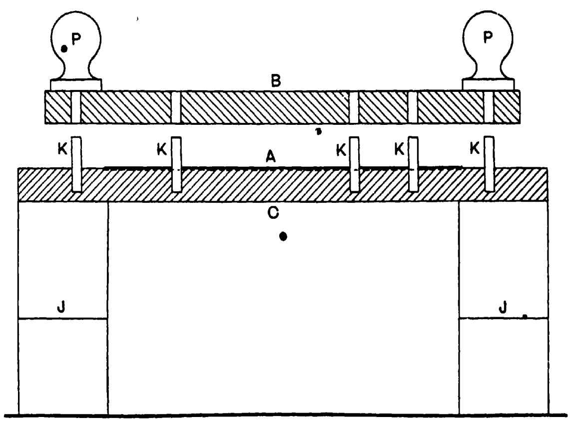


FIG. 64.

Plate C is fixed in a simple wooden framework J, and projecting from the upper side of this plate is a series of pins K, Fig. 64, which fit into corresponding holes drilled in the top movable plate B. A rectangular recess in the fixed plate C corresponds to the size of the card, and when the card and the upper plate B are in position, as shown in Fig. 63, all is ready

for the cutting to commence. When the card used is a short one, such as the one illustrated, it matters little which end of the card operates the first row of needles in the jacquard, hence the card-cutter may commence to cut either from the left-hand side or the right-hand side. A right-handed person would probably prefer to start on the right hand of the plate, in which case D may be taken as the first hole for the first needle in the jacquard. Assuming this to be the case, the design would be turned through 180 degrees so as to bring the junction of the first thread and the first pick to the top right-hand corner. The card-cutter would then read from right to left on the top row of the design, and proceed from right to left on the plate, taking the short rows of 8 in regular succession, starting with hole D. If the card-cutter started at the point E it would be unnecessary to turn the design as in the above case; the design would be the right way up, and the cutter would read along the bottom line from left to right, and take the short rows of holes in succession from left to right. The card would be numbered at the end where the cutting was started. A slightly different method is necessary for the larger cards.

It is a usual plan to prepare point-paper designs so that the bulk if not all of the painted part represents the sections which are to be cut, although in special cases the principle may be departed from. It is much easier, however, to cut marks, as it is technically termed, than to cut blanks, and we shall always assume, unless it is specially mentioned otherwise, that the painted portion of the design represents the threads in their highest position, or warp on the surface, and consequently represents cut portions of the cards for most classes of jacquards.

The card-cutter first takes the large punch L, Fig. 63, enters it in turn into each of the two large holes G, Fig. 65, near the ends of the plate, and drives it through the card for the peg holes as indicated in Fig. 63. He then takes the smaller punch M, punches two holes H at each end of the card for the lacing twine, and then with the same small punch proceeds to cut the card at those points which correspond to the marks on the design-paper. It will be evident from Fig. 63 that the punches L and M must pass entirely through both plates and be withdrawn from the underside. This is the chief drawback with regard to this particular type of hand-plate, and although it is used successfully for cutting cards for dobby machines, it is not so satisfactory for the hand-cutting of jacquard cards; there is a tendency for the card-cutter to lose the position in the various rows. The cutter illustrated at N, Fig. 65, is much more satisfactory for this purpose, since it is unnecessary for the punch to pass through the plate, and the card-cutter can transfer the punch from hole to hole in any row with greater accuracy. The actual cutters are secured to the handle by a small screw or set-screw.

It is absolutely essential that the holes in the two plates B and C should coincide, not only with each other, but with the pitch of the needles in the jacquard. In order that the two plates may always be in the same relative positions, the pins K may be irregularly spaced, or more pins may be placed in one half of the plate than in the other half; when this arrangement is adopted the plate cannot be turned end for end. Any arrangement of pins will do, and one system is illustrated in Figs. 64 and 65, where five pins are shown in each long side, three on one side of the centre and two on the

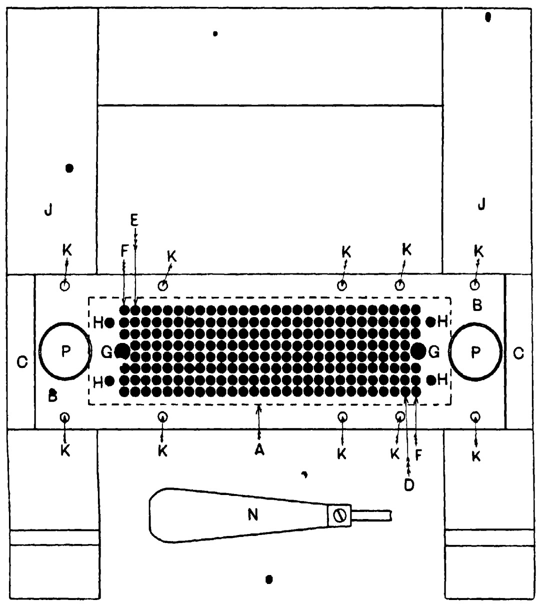


Fig. 65.

other. In Fig. 64 the upper plate is shown lifted clear of the pins, and the card is in its proper position on the bottom plate C.

Fig. 66 represents an elevation of a frame of a simpler nature, for which punch N in Fig. 65 would be used. The upper plate B in this frame projects over both ends of the lower plate C and the framework, so that the overlapping parts may provide means for removing the upper plate in order to insert the card, and also to replace the plate ready for cutting. Knobs P in Figs. 63, 64, and 65 serve the same purpose for the frame illustrated in those figures.

This simple method of cutting cards is practised only in exceptional

cases, for it is evident that the work, even at its best, is performed exceedingly slowly, and the process is suitable only for the cutting of cards for use on small jacquard machines and in cases where a comparatively small number of cards are required for each machine. Practically all card-cutting for cards which are intended for ordinary jacquards, as well as for many special types of jacquards, is done on what is termed the piano card-cutting machine.

Although piano card-cutting machines by different makers vary slightly in detail, the chief features in all these machines are very similar, and Fig. 67 is a general view of the machine made by Messrs. Devoge & Co., Manchester. The point-paper design is shown clearly on the reading board, and the partially punched card is shown with the fore-end gripped by the rat-trap of the carriage, and the rear-end in the guides near the front of the machine. All the other parts will be recognised in connection with the line drawings, of which Figs. 68 and 69 illustrate side and front elevations. In this machine, as in most others, one short row of 8, 10, or 12 holes represents

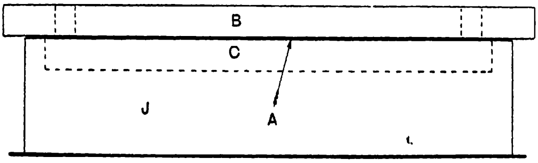


FIG. 66.

the amount which may be cut at one operation, and since this is the case, it is necessary that the successive positions of these short rows shall be placed in regular order immediately under the 8, 10, or 12 punches. The punches are held in position in the headstock A, which will be described later, and this headstock controls the punches in such a way that any desired order of cutting may be easily achieved. The card B to be cut is placed between a fixed guide C and a movable guide C^1, and is supported by and slides along the ledges of the two guides. When the headstock A is in its highest position the card B is entered through the slot D between the top and bottom plates E and F, both of which are drilled to correspond with the pitch of the needles in the short rows of the jacquard, and the holes are naturally just large enough to allow the punches clearance for working. The card, as stated, passes between these two plates, and the end is gripped by a suitable rat-trap catch G fixed to and moving with the carriage H. Now after each short row or the necessary part of a row has been cut, it is clear that those punches which have been forced through the card and into the holes of the lower plate F must be withdrawn before the card can move, and that the carriage H must also draw the card backward a sufficient distance

in order that the position of the next short row shall be under the punches. This double action is performed by the action of the card-cutter's feet on the treadles J and K, both of which are fulcrumed at L.

In the position shown in Fig. 68 the treadle J is in its lowest position,

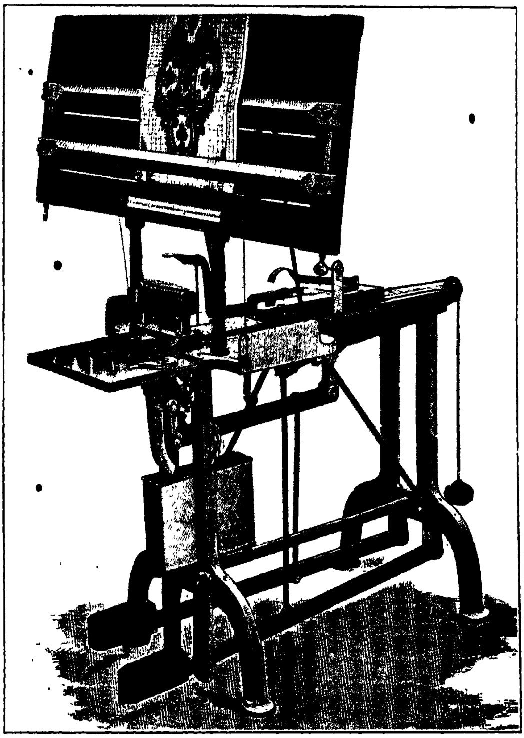


FIG. 67.

and the treadle K in its highest position. These are the positions occupied by the treadles :

(*a*) When the card is entered through slot D ;
(*b*) When the card-cutter selects the necessary keys and therefore the punches for each short row ;
(*c*) Immediately before the punches are carried down by the head-stock A.

It will be seen that the downward movement of treadle K will impart a

similar but shorter movement to rod M, which in turn will pull down the end N and raise the opposite end O of the short lever fulcrumed at P.

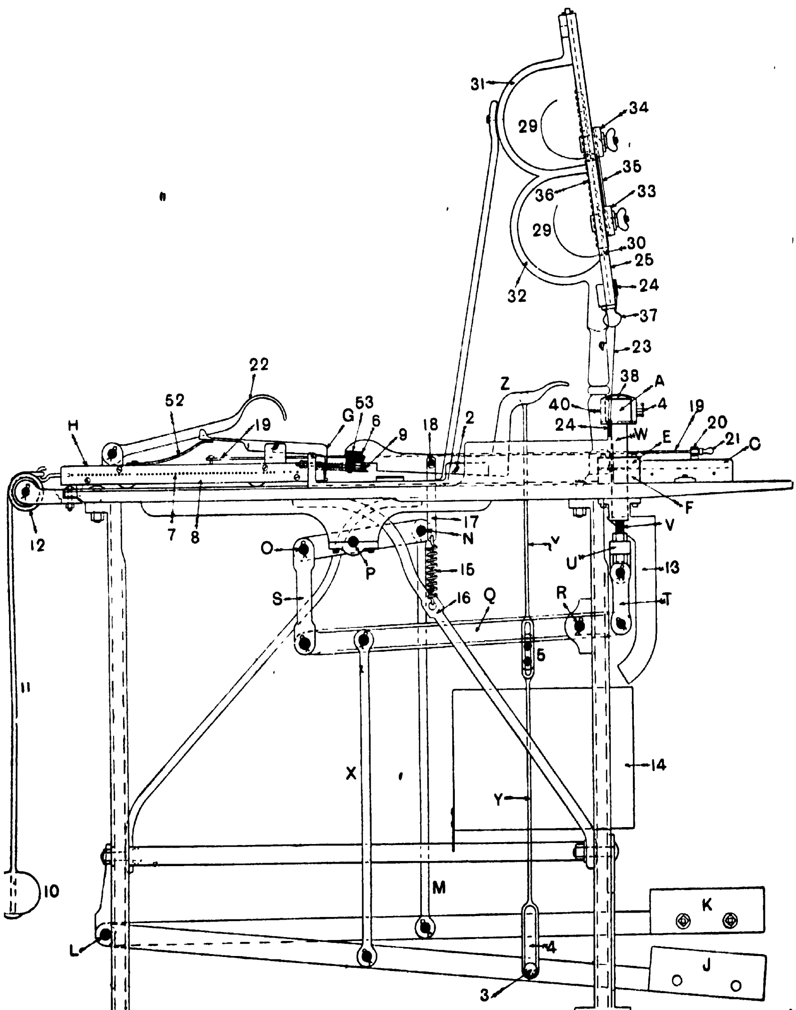


Fig. 68.

Simultaneously, the long arm of lever Q, fulcrumed at R, will be raised through link S and the short arm of lever Q; the latter is attached by link T to cross-bar U. The two ends of cross-bar U carry the two bolts V, which

are fixed to and operate the headstock A. It will thus be seen that when the right treadle K is depressed, the cross-bar U will cause the two slides W to move downwards in their sockets, and the headstock A will move with them. In virtue of the decreased leverage of the various levers, it follows that the cross-bar U and the headstock A will move downwards through only a short distance—actually a quarter of an inch—which, however, is quite sufficient to force the punches through the card. It will be observed that the left treadle J is also connected to lever Q by means of rod X, and attached by the adjustable rod Y to the handle of the escapement lever Z, fulcrumed at 2.

It has been shown that a downward movement of treadle K imparts an upward movement to the long arm of lever Q; hence the latter, through rod X, raises treadle J, and as treadle J rises, the stud 3 moves upwards in slot 4 of rod Y without imparting any movement to the latter or to the end of escapement lever Z. Treadle J will now be in its highest position, and, in virtue of the connections shown, it is evident that a downward movement of treadle J will impart an upward movement to treadle K, and hence an upward movement to the headstock A. When the left treadle J is approaching its lowest position, the stud 3 comes into contact with the bottom inner curved part of slot 4 in rod Y, and imparts a slight downward movement to the latter. The extent of this depression is accurately adjusted by means of the connection 5, and is just sufficient to lift the top catch 6 of the escapement on the end of lever Z clear of the pins 7 in rack 8. A special and essential provision is made in this escapement, and in all similar ones, to ensure that when the carriage is liberated by the withdrawal of the above catch 6 from between the pins 7, a similar catch 9, fixed to a sliding block, will prevent the carriage from being drawn too far back by weight 10, which is attached to the back of the carriage H as shown by means of a rope 11 passing over pulley 12. In Fig. 68 the whole of the carriage is clear of the escapement. The small discs of cardboard which are punched out of the card drop into a funnel-shaped chute 13, and ultimately into a box 14.

The lever Z, which carries the escapement, is thus positively moved in one direction by stud 3 in treadle J, and it is negatively returned to its normal position by spring 15 attached by one end to stay-bar 16, and by the other end to link 17. The latter is hooked on a stud 18, which projects from the face of the lever Z.

A cord 19 is attached by a screw to carriage H, is passed through a brass eyelet 20, see also Fig. 69, in the movable guide C^1, and has a knot tied on, or a handle 21 attached to its end. This cord is for the purpose of drawing the carriage forwards and into close contact with blocks E and F when starting to cut a new card, or for altering the position of the carriage for

any other reason. The carriage is shown in Fig. 68, very near the back of the machine in order that a full view of all parts may be seen. In practice, however, the carriage never reaches this extreme position ; indeed, in this and nearly all other machines a horizontal rod is supported by a bracket from the table (see Fig. 67), and this rod, which overhangs the narrow part of the carriage, arrests the handle 22 and thus stops the carriage soon after the last pin of the row 7 leaves the catches of the escapement. A thin cord 23, seen best in Fig. 69, is also attached to the carriage, and passes over suitably arranged guide pulleys 24, and across the front of the reading board 25. A small weight 26 is attached to the end of this cord, and a metal or other pointer 27, or else a knot tied on the cord itself, passes in front of a numbered index card 28, so that as the carriage recedes during the cutting operation, the pointer moves from right to left and from hole to hole on the index card 28. In Fig. 69 the pointer 27 is near the right end of the index card 28, whereas in Fig. 67 it is not far removed from the left end.

Practically a full sheet of design-paper is shown in Fig. 67 pinned to the reading board, but only a small piece 29, Fig. 69, is shown on the reading board 25 in the latter figure. There are two slots in the board (see Fig. 67), but only one, marked 30, is shown in Fig. 69. The design-paper may be passed through both slots, or through only one as indicated in Fig. 67. If it goes through both as shown in Fig. 68, it is first placed in the semicircular part of bracket 31, passed through the top slot 30, down the face of the board, and as the cutting proceeds the end is entered through the lower slot 30 and then into the semicircular part of bracket 32. In many of the latest machines these semicircular parts are dispensed with.

The straight edge 33 is joined to its companion 34 by flat iron strips 35, and the two straight edges being thus joined can be moved up and down the board as required by means of the square threaded vertical screws 36, which are operated by thumb-screws or milled heads 37. The latter are sometimes grooved, and a cord passes round both so that the cutter may move the straight edges by drawing the cord in the desired direction.

A good general idea of the mechanism of the headstock A will be gathered from Figs. 70 to 73. The wooden cap 38 is shown in position in the three latter figures, which are sectional end views, but in the plan view, Fig. 70, it has been removed, and thus practically all the mechanism of the headstock is exposed to view. The sectional views are taken from the left, as indicated by the large arrow in Fig. 70.

Twelve ordinary punches 39, each approximately $\frac{1}{5}$ in. in diameter, and the majority 4 in. long, appear in the same plane, and each is provided with a shoulder similar to those shown in Figs. 71 to 73, by means of which it is prevented from dropping out, and also raised when required by the

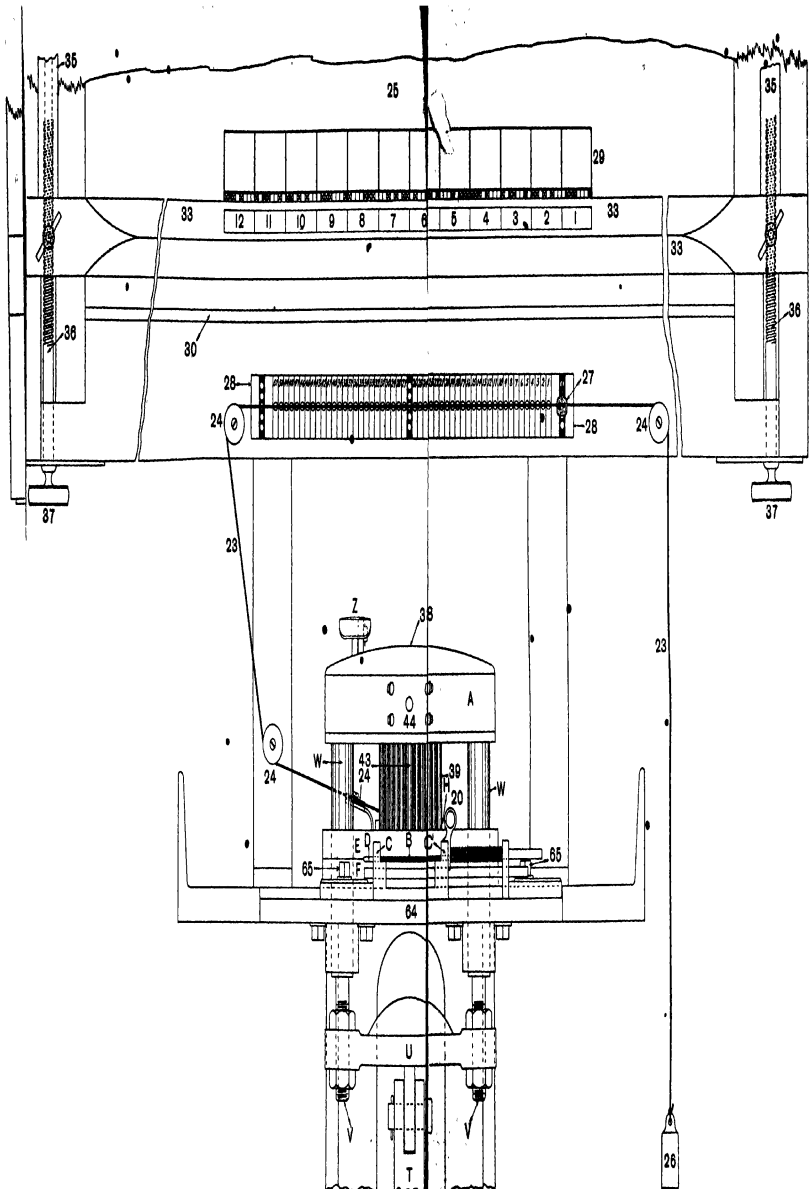


Fig. 69.

To face page 104.

headstock A. Each punch 39 has its corresponding key 40, 41, or 42, which is kept in position by a spiral spring 46 on the stem of the key. A larger punch 43 is also provided immediately in front of the twelve ordinary ones,

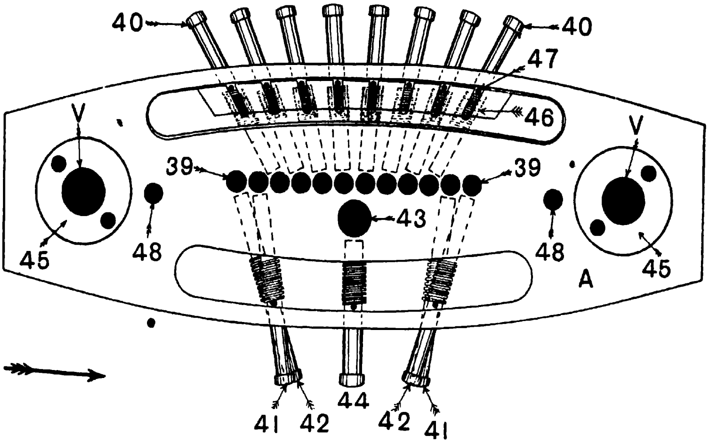


FIG. 70.

and this also has its key 44. The upper ends of bolts V (see also Fig. 69) are secured by circular nuts 45, which may be unscrewed or screwed by means of a two-pronged turnscrew and the two holes in each nut.

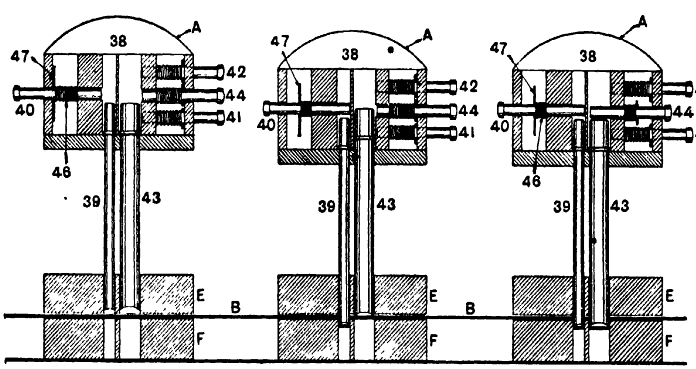


FIG. 71. FIG. 72. FIG. 73.

The middle eight punches are for 400's or 8-row cards, and they are operated by the eight keys marked 40 at the back of the headstock A. For a 500's or 10-row machine ten punches and ten keys are required ; in this case the two keys marked 41 at the front of the headstock operate the

second and eleventh punches in the row. Finally, for a 600's or 12-row machine all the punches 39 and keys 40, 41, and 42 are utilised. Some 600's machines are made with short rows of eight, and the cards for these would naturally be cut with the eight middle punches; in this case, however, the carriage H is considerably longer than the one shown in Fig. 68. Although there may be certain advantages in such a card, it is not considered to be as useful a size as the 12-row cards, which are most common for this size of machine.

The action of the mechanism is as follows: When the headstock A is up, as shown in Fig. 71, the tops of the punches 39 and 43 are below the level of their respective keys. It will be understood that the punches for those keys in the low position, and the punches for those keys in the high position, are shorter and longer respectively than are those for the keys in the middle row, and the punches shown are representative only of this row. When the headstock A is in the highest position, as indicated in Fig. 71, the selection of keys, according to the marks on the design-paper, is made, and these keys are pressed inwards. This action will clearly place the inner ends of the selected keys immediately over the tops of their respective punches, and when the headstock A is drawn down by the right treadle K and the connections indicated in Fig. 68, it follows that the punch, say 39 in Fig. 72, will be forced through the card B by the key 40. At the same time the punch 43, and all others which are not under the control of their respective keys, will simply rise in their holes, or at least will rest stationary upon the card B, while the headstock A moves downwards; the position of the shoulder of punch 43 in Fig. 72 shows that this is the case.

In Fig. 73 an ordinary key and the peg-hole key have been pressed over the tops of the punches 39 and 43, and both the latter are shown as having passed through the card B. (A clearance is shown between the key and the top of the punch, but it will be understood that the two are in close contact when cutting is taking place.) The cutting face of each punch is concave in order that it will enter the card gradually, and thus effect the cutting more easily. When the fingers are removed from the heads of the keys, the springs 46, which are compressed by the pins 47 that pass through and move with the keys, exert their force on the pins 47 and thus place the keys in their inactive position. The pins 47 are kept vertical and out of each other's way by being caused to move in the slots of the brass plate which covers the springs.

Two pins project from the underside of wooden cap 38, and enter the holes 48 in the headstock A, Fig. 70. The small or ordinary punches are used for the design and for the lacing holes, whereas the large punch 43 is used solely for cutting the holes for the pegs of the cylinder.

Before describing the remaining parts of the machine, it will probably

be best to indicate how the design is read, and the manner in which the holes are cut. We have already stated that the card B is drawn backwards by the carriage H a distance equivalent to the pitch of the short rows every time the left treadle J, Fig. 68, is depressed. We have also seen that the downward movement of the right treadle K results in a downward movement of the headstock A. Now since all the punches are held by their shoulders in the headstock A, it follows that when no card is in the slot D, Fig. 69, the punches will partially close the slot when the headstock is down; consequently, the left treadle J must always be down and the headstock up before a new card can be entered through the slot D. But when the parts occupy these positions the carriage H cannot be kept in close contact with the back of plates E and F—*i.e.* in the full forward position—but always moves back a short distance when released by cord 19. This is because at this time the catch 9 is between two of the pins 7, and when the cord is released the weight 10 pulls the carriage back until the said catch reaches the next pin. This motion will be explained fully shortly.

In order that the carriage may be kept in close proximity with the plates E and F—*i.e.* when the pointer 27, Fig. 69, is opposite the right-hand black band of index card 28, as illustrated—it is necessary that both treadles should be moved slightly until both catches 6 and 9, Fig. 68, are in contact with the pins 7 while still leaving the headstock A in such a position that the keys may be easily pressed in if required; if the treadles are moved too much the catches and pins may still be in contact, but the tops of the punches may be above the level of the key holes, and thus prevent the keys from entering. Commencing operations, then, with the pointer 27 in the place indicated, three keys, the second and the seventh in the back row of Fig. 70, as well as the middle one, 44, are pressed in for a 400's card, and the right treadle depressed. This combined action cuts the three holes marked 49 and 50 in Fig. 74. The left treadle J is now depressed, which, by the connections, allows the carriage to recede and to take the pointer 27 to a position approximately midway between the black band and the hole marked 1, Fig. 69, on the index card 28—actually a little nearer to 1 than to the black band. This position corresponds to the place in the jacquard where extra needles are often inserted, and is the same as that occupied by the 6 holes marked F in Fig. 65. The right and left treadles are again depressed in the order mentioned, when the corresponding movement of the carriage H places pointer 27 opposite No. 1 on the index card. If we assume that all the 51 rows are utilised for the design, the cutting for the latter will start with the pointer at No. 1.

In Fig. 69 the straight edge 33 is immediately underneath a greatly enlarged section of design-paper 29, the large squares representing the blocks of 8-by-8, and the small squares representing the line which is to be cut.

The card-cutter reads 8 of these small squares, those between the heavy vertical lines, at a time, and since bar 1, which corresponds with 1 on the index card, shows marks on the first, fifth, sixth, and seventh squares, the keys for these numbers will be pressed in and the right treadle then depressed; holes will thus be punched in these four positions on the first row of the card immediately below the large peg-hole 50, Fig. 74. The left treadle is then depressed, which allows the carriage to recede and to draw the card with it, as well as to take the pointer 27 opposite No. 2 in the index card 28, Fig. 69. Bar No. 2 on the design-paper 29 is now taken, and the right and left treadles pressed down alternately. This order is continued, taking the proper readings from the design-paper until the pointer 27 reaches the black band between Nos. 26 and 27 on the index card. At this point the second and seventh are cut for the centre lacing of the cards; the cutting for the pattern then proceeds as usual from No. 27 until the pointer reaches No. 51, at which point the keys for the last bar on the design-paper, as well as the large key 44 for the peg-hole, are pressed in and the card cut. Finally, when the pointer reaches the last black band, the second and seventh keys are again pressed in, and the card cut for the third line of lacing. Then, with the right treadle still down, the card-cutter takes hold of handle 21, Fig. 68, pulls card guide C^1 a little to the right so as to allow free movement to the card, presses down lever Z to withdraw catches 6 and 9 from pins 7, depresses the left treadle J to lift punches out of card and above slot D, and then pulls the carriage forward by handle 21 and cord 19—an action which obviously forces the card in advance of the carriage. Since a complete card is cut in about a minute, it follows that the whole operation is done in less time than it takes to describe even the movements which are performed for withdrawing the card. When the carriage has been thus drawn forward, lever Z is released, so that the carriage may be kept stationary by the catches, and lever 22 is pressed down in order that the card may be removed from the grip G.

The holes in the successive rows in the card would then represent the marks on the design-paper. Thus, the holes in card B, Fig. 74, represent the marks in the squares immediately above the straight edge 33 in Fig. 69.

Fig. 74 is a plan of the front part of the machine, and it shows distinctly that twelve short rows of the card B have been cut, and that the thirteenth row is immediately under the punches. The card in Fig. 74 shows that the cutting started as mentioned on the first row, but the actual starting point will naturally depend upon which particular row of the jacquard controls the first eight threads in the design, and this in turn is to some extent dependent upon the weaves to be used and the disposition of the ornament on the design-paper. It has already been pointed out that with detached figures the number of needles in use must be a multiple of the ground weave,

and although there are several things which prevent ideal conditions obtaining, it is evident that under certain circumstances the most desirable number of needles to be in work is that one which contains the greatest number of factors, and still keeps in use practically all the needles in the

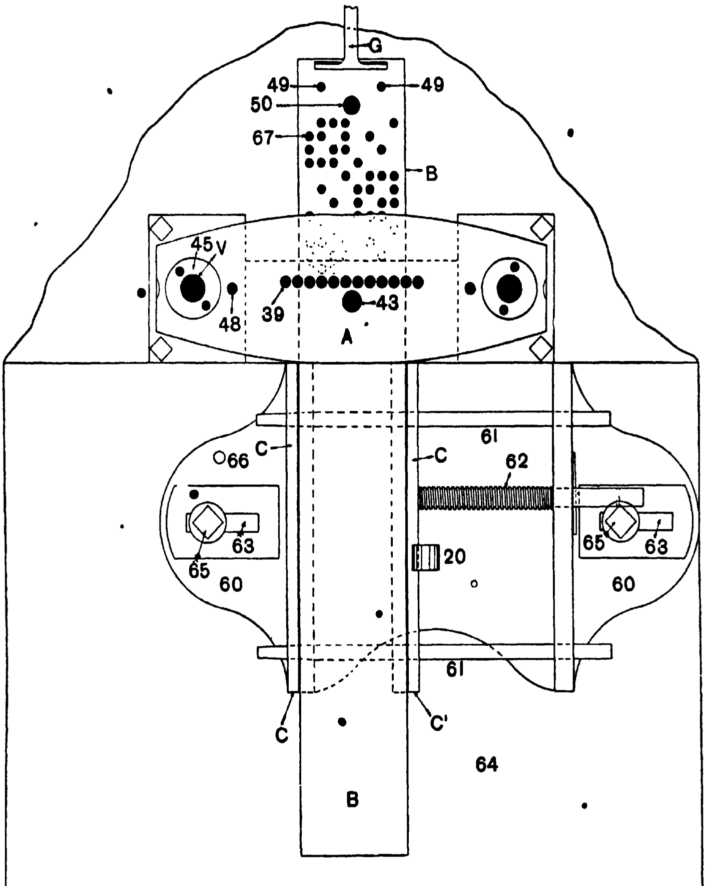


FIG. 74.

jacquard. Thus, with a constant sett of the warp, and with the jacquard mounted or tied up for 384 needles and hooks, a larger number of different ground weaves could be employed for different designs than is possible with any other number in a 400's jacquard. It is evident, however, that, except in special circumstances, this number would be unsuitable for 5-thread

weaves; indeed, for practically all kinds of designs intended to be developed in 5-thread weaves, the number of needles employed would be a multiple of 5.

Although the marks on the single line of design-paper in Fig. 69 (facing page 104) are not representative of any particular design, but have been taken irregularly to show the method, we may assume that the twelve blocks of eight squares each represent the first pick of a design which is complete on 96 threads. There will therefore be four repeats of each pick on its corresponding card.

96 thds. per pattern × 4 repeats = 384 needles to be used.
408 needles − 384 needles = 24 needles and 24 hooks not required for the figured part of the cloth.
= 3 full rows of 8.

If one of these three rows is reserved for selvages (say, the first row), then two rows must be left idle, and these may be at either end. A suitable arrangement would be as under:

Row No. 1 = selvages.
„ 2 to 49 = for design.
„ 50 and 51 = idle.

If the draft in the harness reads from back to front as illustrated in Figs. 5 and 9, and in the upper diagram in Fig. 3, it is necessary to turn the design through 180 degrees, so that the first thread and the first pick will start on the right as shown in Fig. 69. Then the bars or blocks of eight small squares are read in regular succession from right to left, and the pointer 27 in Fig. 69 must also move from right to left as the carriage H, Fig. 68, recedes, in order to indicate on the index card the exact position or block of the design paper for the guidance of the card-cutter when he or she desires to compare the two. When the first thread in the warp is through a mail of the harness cord at the front of the comberboard or harness-reed, as indicated in the lower diagram in Fig. 3, and the warp threads drawn from front to back, the bottom needle of the jacquard controls the first hook and thread. In this case the pointer 27, Fig. 69, would be attached to the carriage H in such a way that as the latter receded the former would move from left to right in front of the index card 28. It would then be unnecessary to turn the design through 180 degrees. In both cases the cards would be numbered consecutively, and at that end which was cut first.

When the designs to be reproduced are intended to occupy a large area on the cloth, as, for example, in table damasks, crumb-cloths, curtains, floor covering, and similar textures, it is a common practice to utilise as many needles and hooks as possible; consequently, with 5-thread weaves and a 400's jacquard there are usually 400 hooks out of the 408 tied up for figuring

purposes, and the odd row or first row reserved for the selvages and the narrow stripes which adjoin the selvages. Let us assume, for example, that Fig. 75 represents 8 picks of a design on 400 threads. The first bar or block, marked 1 on the design-paper, represents the first row of needles and hooks in the jacquard; but the design shows that the first, second, and third vertical rows of small squares are unmarked, and consequently the first, second, and third needles and hooks are idle, unless they happen to be utilised for, say, the two outside threads at each selvage, or for the $\frac{2}{2}$ basket border, or for some such simple but necessary work, independent of that represented on the design-paper. The fourth to eighth threads inclusive in the first bar or block represent the weave for the narrow stripes, and these stripes in damasks are termed the simple satin part; they adjoin the selvages, and sometimes appear in other parts of the fabric. This weave is naturally continuous throughout in the way of the weft. Bars or blocks, Nos. 2 to 51, of which only up to 7 are illustrated in Fig. 75, are for the figure, and, although in certain sections of the 8 picks illustrated the weave is shown continuous, it will be understood that the weaves in all parts except bar No. 1 change from point to point, somewhat as illustrated in bars 5 and 6, and are therefore quite different from that marked in bar No. 1. For cutting purposes the design would be turned through 180 degrees if intended for the arrangement shown in Fig. 69.


1 2 3 4 5 6 7→51

FIG. 75.

It will be noticed that when the point-paper design is painted in solid black or in any other opaque or very thick paint, it is impossible to distinguish the heavy dividing lines, so that no design should be made as shown in Fig. 75. The same design appears in Fig. 76, turned through 180 degrees ready for cutting, but dots have been introduced instead of solid squares; this certainly enables the marks in the heavy sections to be seen more clearly in conjunction with the heavy dividing lines, but in practice neither method would be adopted, on account of the difficulty involved and the time taken in introducing the weave into the figured portions. The usual practice is to paint all over the figure with red, introduce the ground weave in red, and then with either white or black paint insert marks on the already fully painted figure to indicate where the threads are to be left down. In cutting, the operation is then to cut all

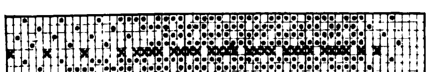

51←7 6 5 4 3 2 1

FIG. 76.

red in ground and figure, and to leave everything else uncut. The line in crosses in Fig. 76 is represented on the card B in Fig. 78.

Figs. 77 and 78 represent on a large scale an elevation and a plan of the carriage H, together with the parts which control the movements of the carriage. As already mentioned, a blank card is placed between the fixed and movable card guides C and C^1, Figs. 68 and 69, the left treadle J being down and the headstock A being up. The punches are in consequence above the slot D, and therefore the card can be pushed easily through the slot until it comes into contact with the end of the carriage H or the rat-trap grip G. It is, of course, necessary that the card B should be firmly gripped between the small projecting part 51, Fig. 77, and the teeth of the grip G after the card has been placed between these parts. In order to enter the card B, it is necessary to press down the end of lever 22, the latter in turn forces down the left-hand end of lever G and raises the right-hand end of the latter, then when the card has been placed between the points of G and the piece 51, handle 22 is released and the spring 52 causes the rat-trap G to grip the card B.

Attention has already been called to the fact that the cutting is done by pressing down the right treadle K, Fig. 68, while, on the other hand, the downward movement of the left treadle J allows the carriage H to be drawn back a distance equal to the pitch of the pins 7 in rack 8. Thus, when the treadle J is nearly at the bottom of its stroke, the pin 3 comes in contact with the bottom of slot 4, Fig. 68, and causes a slight downward movement to be imparted to rod Y. This causes the right-hand end of lever Z to move in the same direction against the pressure of spring 15; the left-hand end of lever Z, which carries the escapement, consequently rises slightly. In Fig. 77 the escapement is down, while in Fig. 79 it is up.

The escapement is composed of a block 53 on the end of lever Z and this block carries the fixed catch 6. The sliding catch 9 is fixed on the end of a bolt 54 supported by and free to move in the block 53 and the projecting part 55 at the end of lever Z (see Fig. 78). A spiral spring 56 encircles the bolt 54, and tends to keep the catch 9 to the right as shown in Figs. 68, 77, 78. In this position it will be seen that the fixed catch 6 is between two of the pins 7 of the rack 8, thus preventing the carriage H from being drawn backward by the weight 10, Fig. 68; while at the same time the sliding catch 9 is under and quite clear of the pins 7.

Immediately rod Y is depressed, however, the catch 6 is lifted clear of the pins 7; but simultaneously catch 9 is placed in the position which has just been vacated by catch 6. The pull of the weight 10, Fig. 68, now draws the carriage H backwards until the sliding block 57, Figs. 77 and 79, which carries the catch 9, comes into contact with the recess in part 53. When this happens, both catches 6 and 9 are in one plane, as shown in

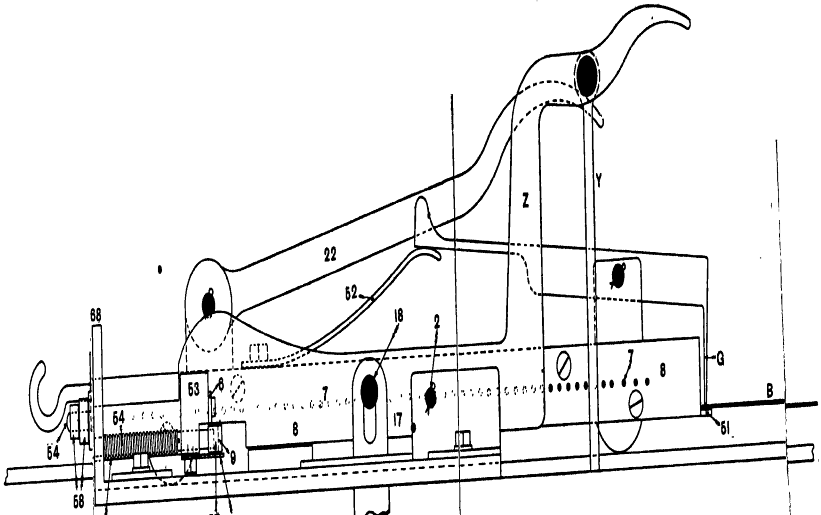


FIG. 77.

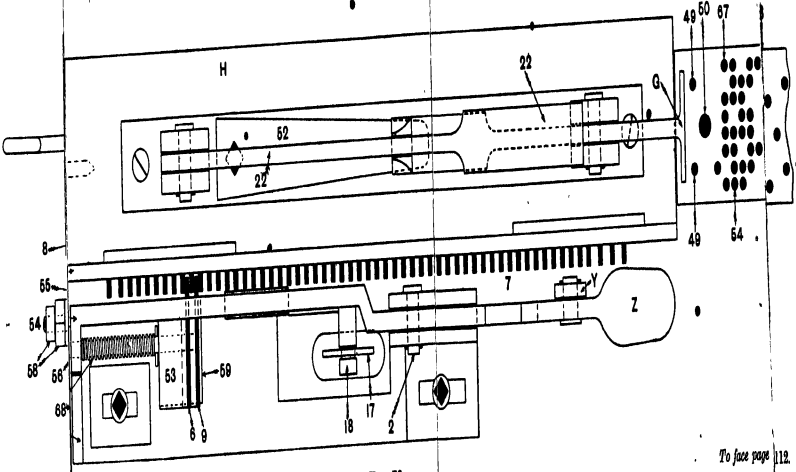


FIG. 78.

To face page 112.

Fig. 79. The distance through which the carriage H moves is the pitch of the pins 7, and the necessary adjustment to obtain the correct distance is made by nuts 58 on the end of bolt 54.

From the connections shown in Fig. 68 it will be clear that the two treadles J and K always move in opposite directions, so that immediately the treadle K is pressed down, the stud 3 rises in slot 4, and hence the spring 15 and link 17 draw the left-hand end of lever Z downwards until the escapement assumes the position indicated in Fig. 77. Thus, in Fig. 79, where the pins 7 are shown rectangular instead of round—both kinds being in use—it is clear that catch 6 will enter between the pins 7 just before the sliding catch 9 leaves them ; and immediately the sliding catch 9 leaves the pins, the spring 56 forces forward the block 57, and therefore the catch 9, into the position shown in Fig. 77, the under surface of block 57 sliding along plate 59, which is set-screwed to the block 53 as shown.

Attention has already been called to the partially cut 400's card in Fig. 74. It will be clearly seen that the middle eight punches of the headstock, Fig. 70, act on such a card. The fixed card guide C and the two soleplates 60 form one piece, while the movable card guide C¹ slides on rods 61, and is kept in close contact with the card by means of the spring 62. It is essential that the side of the card should be in contact with the full length of the fixed guide C, so that the cutting will correspond exactly with the longitudinal rows of needles in the jacquard, and thus ensure a correct selection of needles according to the pattern on the card.

Slots 63 in baseplate 60, Fig. 74, provide means for adjusting the card guides for the different widths of cards. Thus, for a 500's

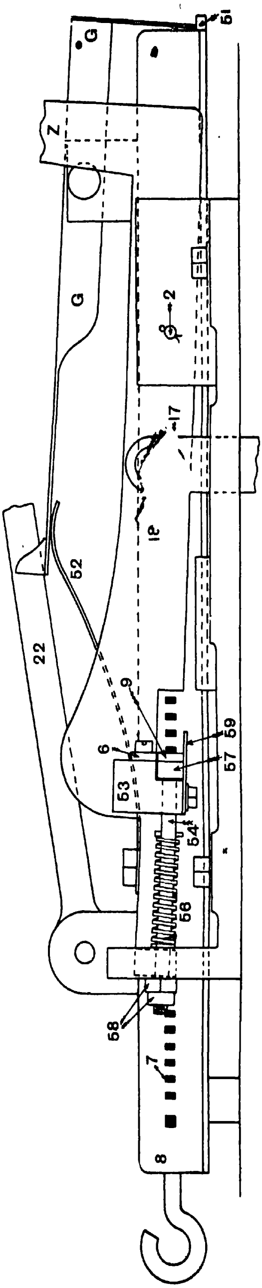


Fig. 79.

or 10-row machine, guide C would be moved to the left a distance equal to the pitch of the punches, and then bolted to the table 64 by the set-screws 65. Similarly, for a 600's or 12-row machine, the same guide C would be moved still farther to the left so as to include the extreme punch on the left. This adjustment requires to be done very accurately indeed, and to facilitate the movement for different sizes of cards it is a good plan to fix the points accurately, then drill a hole through the base-plate 60 and the table 64, so that a pin 66 may be inserted before the plates are screwed down. It will of course be understood that the holes marked 67 on the card are for the pattern. Fig. 80 is an end elevation of the parts illustrated in Fig. 79, and it will be seen that the projecting part 55, Fig. 78, in its up-and-down motions, slides against the side of guide 68, Fig. 80.

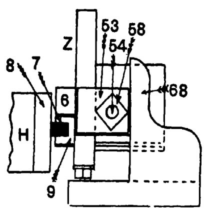
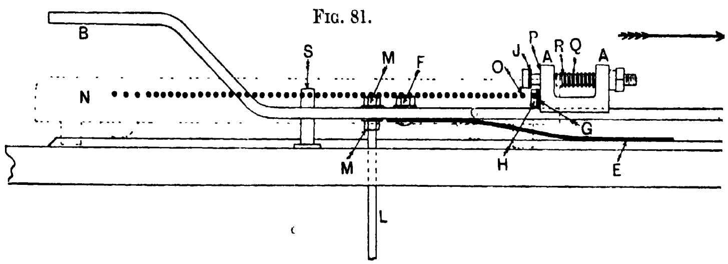


Fig. 80.

The card-cutter already described is intended for what is termed the ordinary British pitch, in which the distance between the centres of any

Fig. 81.



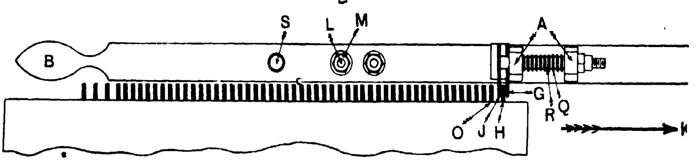


Fig. 82.

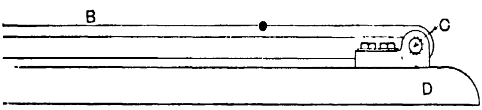
pair of holes is $\frac{7}{26}$ of an inch, or 0·2692 in. It is, of course, easy to fix a headstock of a different pitch, to introduce a new rack on the side of the carriage, and still utilise all the other parts of the machine. Except in special cases, however, the above headstock represents the usual pitch in use, and the only difference between this machine and those of other makers is in the structure or shape of the various parts for performing the same functions. Thus, in many machines the escapement is arranged as illustrated in Figs. 81 and 82, which show respectively an elevation of the pins from the opposite side of the carriage, and a plan. In the former illustra-

tion the carriage itself is supposed to be cut away, but its position with respect to the other parts is indicated by the dotted outline.

The escapement block A is, in this case, secured to the upper face of a long, flat bar B, fulcrumed at C near the extreme back part of the framework D, and kept normally in its present position by means of a flat spring E, one end of which is fixed to the bar B by nut F, while the other end rests upon the top of the table, and is thus capable of sliding about $\frac{1}{8}$ in. along the top when the upper part of the spring is pressed down. In many machines the bar B is itself in the form of a spring, and rigidly fixed to the framework near point C. The main advantage of the former method is that the bar is practically everlasting, since all the negative or return movement is supplied by the spring E, and this is the only part which is subject to any serious wear and tear.

The fixed catch G is shown behind the first pin H, whereas the sliding catch is clear of the pins as illustrated in Fig. 81. The headstock, which is not shown in these figures, would occupy a position on the extreme left, and the carriage N would, therefore, move from it during the operation of cutting in the direction of the arrow K. A small rod L, secured to the bar or spring B by nuts M, passes through a slot in a short stud, which projects from a lever similar to and performing the same work as lever Q, Fig. 68. Small lock-nuts are placed on the end of the rod L, Fig. 81, and the above-mentioned bracket through these nuts carries the rod L down a short distance when the left treadle of the card-cutter is depressed. The downward movement of this rod L takes down the escapement A sufficiently far to withdraw the fixed catch G from the pins of the rack, and to place the sliding catch J in the next slot—that is, into that slot which the pin is immediately above at present in Fig. 81. The weight similar to 10 in Fig. 68, attached to the end of the carriage N will then exert its force on the head of the sliding catch J, through the pin O in the rack of the carriage, and cause the latter to move until catch J is arrested by the front part P of the escapement support.

Fig. 81.



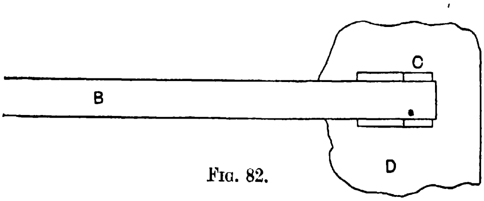


Fig. 82.

During this action the spring Q will, of course, be compressed until the right treadle is pushed down to cut the card, when the fixed catch G will

return to its present horizontal plane, but will enter between the next pair of pins, and at the same time the sliding catch J will leave the same pair of pins. Immediately the catch J is clear of the pins, the compressed spring Q, through a small pin in the rod R, will force the sliding catch J and its support to the left ready to be inserted between the next pair of pins, and so on until the carriage has traversed its complete path and the card has been cut. It will thus be seen that the escapements in the two types of machine perform the same function, but from different positions. The bar or spring B is guided in its up-and-down movements by a pin S, which stands erect from the table D, and passes through a hole in the bar B. Both catches G and J are naturally withdrawn from contact with the pins of the rack when it is necessary to draw the carriage N forward to commence with a new card, or for any other purpose.

Fig. 83 is a sectional elevation of the table, introduced to show up one or two little points. In this figure, A is the carriage which runs upon the supports B. The card is gripped between the teeth of the rat-trap D and the small projecting ledge E in front of the carriage, in the usual way. The solid part C represents a 400's card, while the dotted extensions show the width of a 600's card. Two rail guides F at the same height as the ledge E support the card during all its travel, and when the last row in the card has been cut, the lever corresponding to 22 in Fig. 68 comes in contact with the underside of the overhanging rod G, which, through the action of the weight 10, Fig. 68, causes the lever 22 to be depressed slightly, and thus raises the grip D to free the card. The cutter can then remove the card from the back of the headstock, and thus obviate the necessity of drawing it forward through the slot, as previously explained. It will, of course, be understood that the rod G is supported by bracket H, which is fixed to the table as shown in Fig. 67 ; in many cases, parts G and H are in one piece.

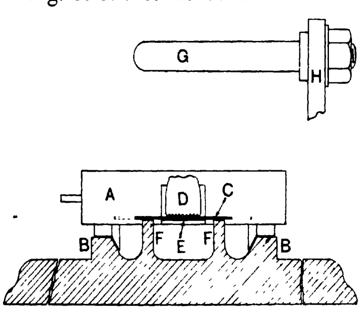


FIG. 83.

The guide rails F are also clearly illustrated in Fig. 84, which illustrates one or two minor details. The lettering in this figure corresponds with that for similar parts in Fig. 83. Part of a headstock in Fig. 84 shows holes for 14 punches in one row, but the keys are omitted. The two outside punches, with corresponding keys, are introduced into some machines to provide means for cutting the semi-circular holes K in 600's cards opposite the lace holes M. For 400's cards the third and twelfth punches

would be used for the same purpose. Some firms desire these holes or snips at the edges of the cards, as they think the lacing is more satisfactory than it is without them. Such semi-circular holes are also required if the lacing is in the form of two or four cords which cross each other between the cards, and so hold the cards in position. The card shown in Fig. 84 is fully cut for five rows in order to show it up distinctly, and the front part of the card is torn away to expose the card guides N. As usual, the left guide N is a fixture when working, but the right guide is under the influence of a spring on pin O, and the latter is attached to the angle-plate P, Fig. 85. In many cases the parts N are dispensed with, and the card is then introduced on the base Q, in which case the gap R between the upper and the lower plates of the headstock is naturally in the same line. The figures show the positions of parts for a 600's card; when it is necessary to cut 400's cards, a channel-shaped guide is introduced, and the sides of this guide fit between the vertical part of P and the edge S of the opposite side.

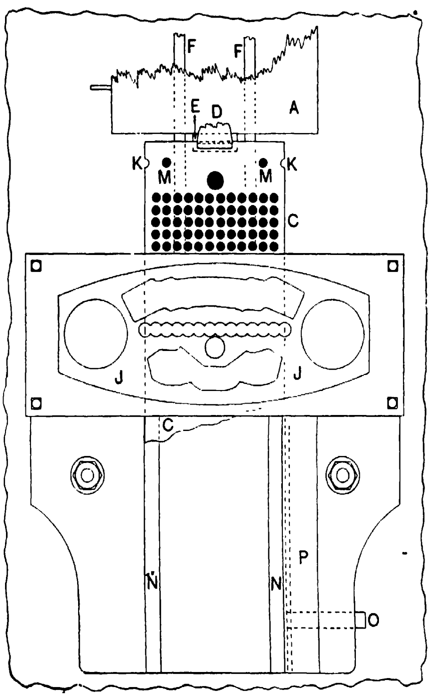


Fig. 84.

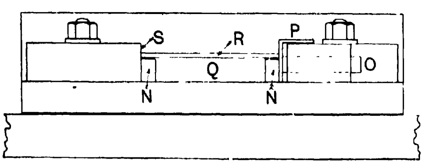


Fig. 85.

When large numbers of cards are required in the production of any type of cloth it is natural that steps should be taken to reduce the cost of the cards as much as possible. If it is essential that the pattern should be woven by what is termed a "full-harness" or "brocade-harness" jacquard, in which each needle controls only one hook, the cost of cards is minimised by the use of a finer-pitch

machine, and this obviously necessitates a different card-cutting machine, or at least a different headstock and carriage to correspond with the pitch of the needles. Figs. 86 and 87 represent a front view and a sectional plan view of such a machine. There are 16 punches in a row; the middle 10 ones—*i.e.*, 4 to 13—are operated by keys A at the back of the headstock, while the remaining 3 at each end, 1 to 3, and 14 to 16, are controlled respectively by keys B, C, and D, and E, F, and G. The peg-hole punch is operated by key H. One complete row, or part of a complete row, according to the number of holes required in any row, is cut at a time, and since there are 16 keys to manipulate, the cutting is evidently a somewhat slow process as compared with the cutting for an ordinary pitch. In all other respects the machine is similar to those which are provided with headstocks for cutting the standard British pitch card.

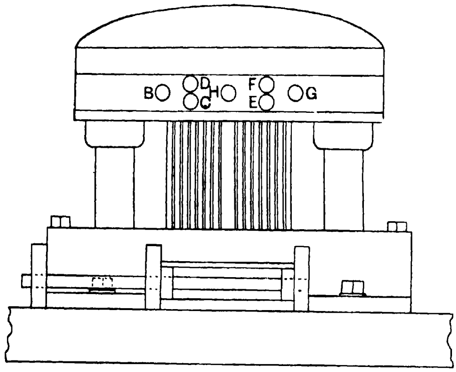


FIG. 86.

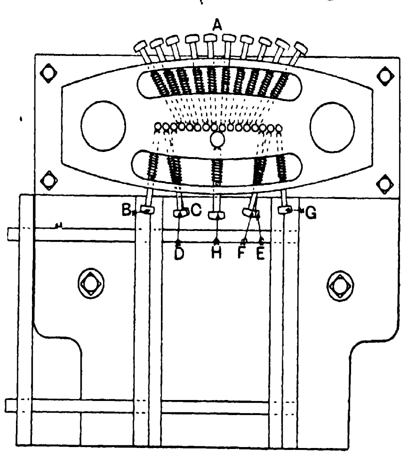


FIG. 87.

In the foregoing description and illustrations of the ordinary card-cutting or piano machines we have purposely omitted the illustration of those in which the keys, or rather in this case levers, are brought above the punches by means of cords. The only difference between these and the ordinary machines is that the above-mentioned levers, which in their normal position are held clear of the tops of the punches by springs, are pulled over those punches when and where required to prevent the punches from rising when the headstock is depressed in the usual way, whereas in the other

machines the keys are pressed over the heads of the punches by the fingers and thumbs of the card-cutter. The levers thus play the same part as the keys in the modern piano machine. In the cord machines the selection of the various levers is made by drawing forward the proper cords from 8, 10, or 12 vertical cords in front of the card-cutter, and in the same plane as the punches. This machine must not be confused with the reading-in machine which was used in connection with the draw-boy, nor must it be taken to be the same as certain Continental machines, although the vertical cords provide a certain resemblance to the above. There are still many of these simple machines in use, and satisfactory work can be obtained from them, but at the same time they can scarcely be considered as modern machines.

Card-cutting by means of piano machines is probably the most suitable way when the cards have to be cut from designs in which weaves appear, and this method of cutting is also considered by many experts to be equally suitable for several kinds of design in which no weaves appear on the design paper. The very fact of both kinds of design being used in the same factory has probably something to do with the adoption of the ordinary piano machine for several types of weaveless designs, for this arrangement, besides making provision for the reproduction of all kinds of designs on to cards, minimises the variety of machines in use in any factory, and at the same time makes sure that the work will be done in an efficient manner by a cutter who is probably accustomed to one particular method of card-cutting.

CHAPTER V

CARD-CUTTING MACHINE FOR BRUSSELS AND WILTON CARPETS

WHENEVER a certain branch of trade assumes large proportions, special types of machines are made, if possible, to perform the work in the most economical manner, for the simple reason that such special machine or machines may be kept fully employed on one particular class or type of goods only. This departure has been followed in several cases with respect to actual weaving, and for somewhat similar reasons we may assume that the plate card-cutting machine known as the Brussels and Wilton card-cutting machine was adopted, and is still used almost exclusively, for cutting cards which are to be used on special jacquards for the weaving of these fabrics. One of these special jacquard machines for the weaving of Brussels and Wilton carpets is illustrated in Fig. 34, and three sets of cards are clearly visible in position on the triple jacquard cylinder.

In the simple hand-plate machine illustrated in Figs. 63 to 66, one punch only is used for the small holes, but in the plate machine for Brussels and Wilton jacquard cards there are as many punches used at a time as there are holes required in the card, and all these holes are cut at one stroke. We need not attempt to deal with the selection of the punches at present, but may immediately proceed to consider the mechanism of the machine.

Fig. 88 is an elevation of the driving end, Fig. 89 a section through the machine, Fig. 90 a front elevation, and Fig. 91 a plan. The machine is, of course, driven by power, and fast and loose pulleys A and B, Figs. 90 and 91, are provided if the drive is to be by means of a belt. These pulleys are placed on shaft C in the particular machine illustrated, and this shaft extends across the machine as shown, and carries a small pinion D of 13 teeth, Fig. 91. This pinion gears with wheel E of 48 teeth, and the latter is compounded with pinion F of 13 teeth on stud G. The pinion F ultimately drives wheel H of 60 teeth on the cam shaft J. This is what might be called the indirect method of driving ; the direct method, in which all the gearing is on one side, is probably more common, and is illustrated in Fig. 92, which is a reproduction from the most modern machine made by Messrs. Boucher

and Co., successors to Prunells Limited, Kidderminster, the original firm of which was Messrs. Prunell, Lamb and Co. The machine was invented by Mr. Lamb more than ninety years ago as a hand-power machine; it was subsequently adapted for power by the inventor. In this case it will be seen that a small pinion on the pulley shaft drives a large wheel on the cam shaft. This shaft is identical with shaft J in Figs. 88 to 91, and all the description which follows, except that of the driving, may be considered as being applicable to this illustration as well as to the line drawings.

Two cams K, one near each side frame, rotate with the cam shaft J, and impart an up-and-down motion to each arm L; a slight oscillating motion is also imparted to the lower end of each arm L, but this is due entirely to the cams and to the fact that the upper ends of the arms L are loose on the shaft M. Shaft M supports the rising and falling block N, and from each end of block N is a pendant arm O, forked at the end as indicated at P, Figs. 88 and 89, in order that the block N may have a perfectly true vertical motion.

The general action of the mechanism having been explained, it will be well to consider the action of the moving block N upon the actual cutting apparatus. This will be understood by reference to Figs. 88 and 89, the latter of which shows the position of all parts immediately after the card has been cut. In Fig. 88 the thick part of the cam K is down, and hence the block N is in its lowest position. The hinged plates Q and R are situated between the sides S and T, the bottom plate Q resting upon and secured to the top of block N. Both plates Q and R are drilled to correspond to a fully cut card, and in Fig. 88 the upper hinged-plate R is open so that a blank card may be placed on the top of plate Q. Particulars of both plates will appear shortly. In the meantime it is sufficient to state that when the card has been placed in position, the hinged lid R is closed down as shown in Fig. 89. It will be understood that the sides, or rather ends, S and T, along with the front and back long sides, form a rectangular opening in the framework in which the block N, with plates Q and R, rises and falls under the influence of the cams K and their connections to the block N. In connection with the cutting of cards for Brussels and Wilton carpets, it occasionally happens that two cards may require to be identical so far as the order and number of the holes are concerned. In such cases both cards may be cut at one operation in the machine illustrated in Fig. 92, as provision is made in the hinging of the plates for this purpose. The punches are graduated in length so that all the cutting force is not required at the same instant, and the machine is accurate in all respects.

The plate U, Fig. 91, which contains the punches, is now placed on the hinged-plate R, Fig. 89, and the cover plate V, which is in its back position in Figs. 88 and 91, has been drawn over the heads of the punches W in Fig. 89,

so that when the thick part of the cam K forces block N upwards, it is clear that the punches W will be forced through the card, or at least the card will be forced against the stationary punches W, which will thus cut the holes required. The card, as already mentioned, is between plates Q and R, and consequently at X in Fig. 89.

When the card is cut, the card-cutter pushes the slide V back into the position indicated in Fig. 88, and then removes the punch plate U, with its punches W, from the machine, and places it upon the stand Y ready for arranging the punches for the next card. Punch plate U is provided with handles Z or their equivalents for transferring it to and from the machine.

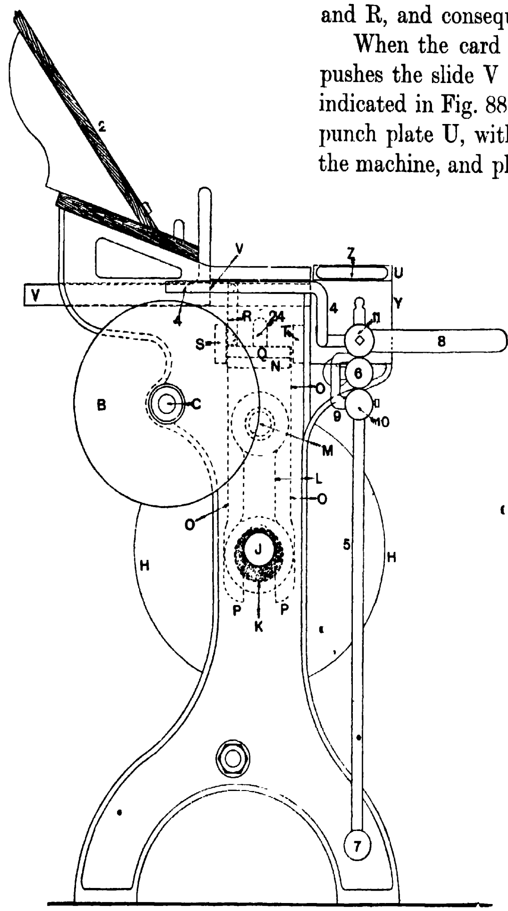


FIG. 88.

Before considering the other views it should be mentioned that the design-paper is placed on the reading-board 2, Figs. 88, 90, and 91, and a straight-edge is used to enable the cutter to read each line of the design correctly. The punches are kept in box 3, Fig. 89, which is conveniently situated for the requirements of the card-cutter. The belt is usually placed on the loose pulley B, Fig. 90, after each card has been cut, by the belt fork 4, supported by rod 5, which oscillates in fixed brackets 6 and 7. The handle 8 is placed near to the operative, and its movements are limited by part 9, which is secured to and moves with ball 10, and in unison with handle 8 and ball 11. The movement of part 9 is checked in both directions by bracket 12, Fig. 91, and this bracket carries the ball 6, Fig. 90.

In Fig. 91 the hinged-plate R is down, and the upper face thus exposed to view. It shows that the plate is divided into three sections as follows:

15 rows of	8	holes in	1st	section	on left;
14	,,	8	,,	2nd	,,	in middle;
15	,,	8	,,	3rd	,,	on right;

or altogether 44 complete rows as a maximum. Four holes in line with the 1st, 3rd, 6th, and 8th long rows are for the lacing, and these naturally appear at four places on the plate. Finally, there are two large holes near the outer lacing holes at each end for the pegs on the card cylinder.

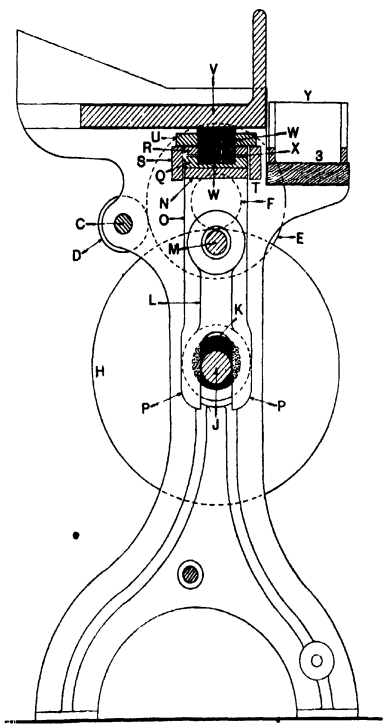


FIG. 89.

The design-paper, or rather two rows of large blocks of paper, full width, are shown at 13 and 14 on the board 2, and the first horizontal row of small squares is illustrated at 15, each small square containing a number 1, 2, 3, 4, or 5. These numbers are placed on the design-paper to indicate five different colours, which in the general and simplest acceptation means a design for what is technically termed a 5-frame Brussels or Wilton carpet. The blocks 13 and 14 are made perfectly square, as usual, but enlarged, and as illustrated are intended to represent 8 small squares each way. Other numbers in the way of the weft are used in practice, the limits usually being 6 and 10.

If we take the holes in plate R, Fig. 91, to represent the positions of 352 needles of the jacquard, the first or leading needle would be represented by the hole 16. Five hooks for the five different colours are operated by four needles in the first row—those opposite hole 16 and the next three holes—and other five hooks are operated similarly by the remaining four needles in the same row. Consequently ten coloured threads, two of each colour, are controlled by each short row of eight needles. It is unnecessary here

to say more about the jacquard than to state that blanks instead of holes opposite the first four needles result in colours 1, 2, 3, and 4 respectively being lifted, but not more than one blank can appear in each group of four; whilst no blank—*i.e.* 4 holes in one group—results in the 5th colour being lifted. Not more than one colour out of five is up at a time. Each group of four acts similarly on its corresponding group of five hooks and five

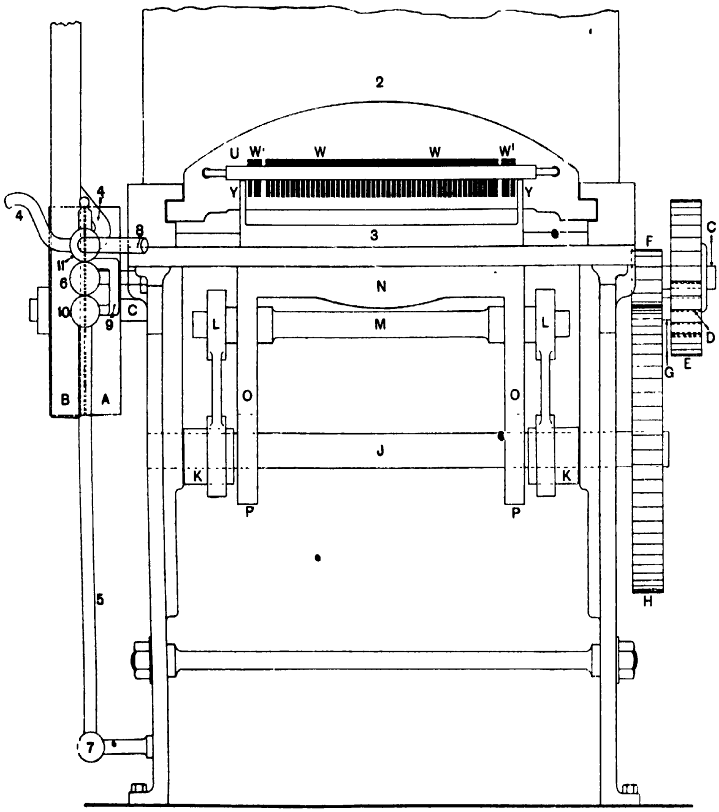
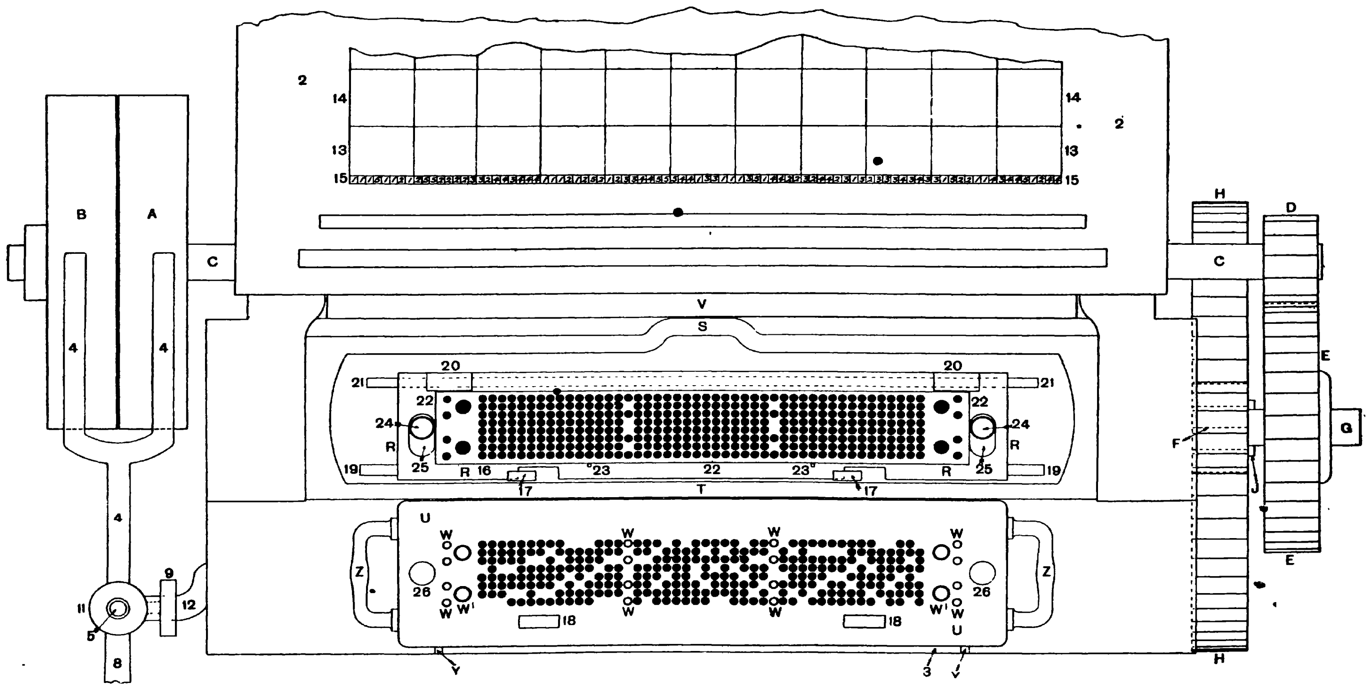


FIG. 90.

colours. It will thus be seen that although there are 352 needles in this section of the jacquard, and provision for lifting 440 threads, there is only one thread lifted at a time for every four needles, and consequently the number of small squares in one horizontal row of the design-paper will be:

$$\frac{352 \text{ needles}}{4 \text{ needles per group}} = 88; \quad \text{or} \quad \frac{440 \text{ coloured threads}}{5 \text{ threads per group}} = 88,$$



2
14
13
15
B
A
C
4
H
D
E
G
F
J
V
S
20
21
22
24
R
19
25
16
23
17
T
U
W
W'
Z
26
18
9
12
11
5
8
3
Y

FIG. 91.

and these 88 small squares are represented on the first line of the design-paper, and marked 15.

Now let us consider the arrangement of the punches in the punch plate U, Fig. 91, to secure an effect of five colours in the cloth according to the arrangement of the five numerals on the design-paper, keeping in mind that a blank opposite 1, 2, 3, or 4 causes the corresponding colour to be lifted, and 4 holes causes the fifth colour to be lifted. Also read the short rows in the punch plate U as being composed of two sections, 1, 2, 3, 4, and 1, 2, 3, 4, instead of 1, 2, 3, 4, 5, 6, 7, 8.

In the first short row on the left on plate U there is a blank in the first position which shows that colour 1 is raised from the first group; a blank in the same short row in the fifth place—*i.e.* opposite the first place in the second group of four—also shows that another thread of colour 1 is raised alongside of its neighbour but in a separate split of the reed. In the third split of the reed another thread of colour 1 is raised because there is a blank opposite the first needle in the second row; while four holes opposite the last four needles in the second row shows that colour 5 would be raised in the fourth split. This order, 1, 1, 1, 5, is the same as that of the first four small squares on the design-paper. Similarly, throughout the row for this card—

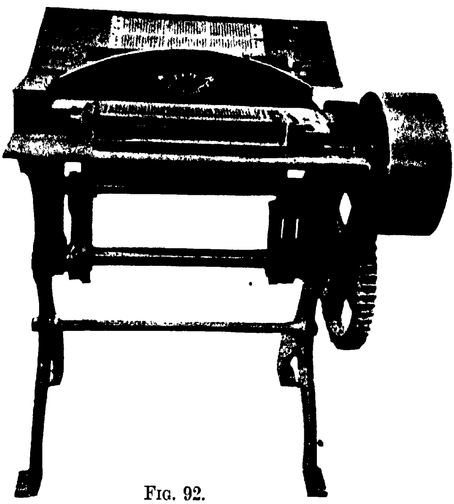


FIG. 92.

If colour	1	is to be raised,	a blank will	appear in	the	1st place;
,,	2	,,	,,	,,	,,	2nd ,,
,,	3	,,	,,	,,	,,	3rd ,,
,,	4	,,	,,	,,	,,	4th ,,
,,	5	,,	no blank will appear.			

The card-cutter thus selects the blanks according to the colour required, and naturally withdraws the punch at this place, if it had not been absent for the previous card. All the other punches for the figure, in addition to those marked W for the lace holes and those marked W¹ for the peg holes, remain undisturbed.

The catches 17 in Fig. 91 are controlled by two pins in a sliding bar, and are held in their present positions by means of a spiral spring attached to the frame and to the left-hand end of the sliding bar. The spring yields, and the catches move to the right when the hinged plate R is closed down; but immediately the plate R occupies its lowest position the heads of the catches protrude through the holes, and are drawn forward to the left to their present position by the spring and sliding bar. The catches thus hold the hinged plate R down securely, and as they rise, due to the upward motion of the block N, they enter the rectangular holes 18 in the punch plate U.

After the card has been cut, the card-cutter lifts the punch plate U and places it in its present position on the top of the punch box; she then draws to the right one of the catches 17, which, in virtue of the connection with the sliding bar, draws the other catch 17, and then by means of projections 19 rotates the plate R about its hinges 20 and hinge rod 21 until it assumes the position indicated in Fig. 88. It is, of course, essential that each card should be cut at the proper places with respect to the ends and sides, so that it will fit correctly on the cylinder of the jacquard and operate correctly on the needles of the jacquard. The exact size of a card for a five-frame jacquard is indicated by the rectangle 22, Fig. 91, and this shows that the back edge of the card comes against the hinges 20, the front edge against two small pins 23, and the two ends of the card against the bases of the upright pegs 24. The latter also serve as a support for the hinged plate R.

The same lettering as in the above figures has been used in Fig. 93. In this figure the hinged plates Q and R are shown opened full out, although it is unnecessary, and indeed impossible, to open them out so far in the machine. The dotted rectangle illustrates the space occupied by a five-frame card. A sectional view through the part for cutting the lace holes appears in Fig. 94; the arrows show how the plate R is rotated with respect to plate Q, the rotation being only through 90°. The end of the card is shown in solid black in this view.

When cards are required for a six-frame Brussels or Wilton, a ten-row jacquard is necessary, and hence ten rows must be provided in the punch plate U and hinged plates Q and R. It is unnecessary to illustrate more than one of these, and plate U in Fig. 95 has been prepared for this purpose. In a similar manner to that already described in the five-frame Brussels, a blank opposite any of the needles which operates the hooks or cords controlling the five colours results in the corresponding colour being lifted, while five holes opposite the needles constituting a group results in the sixth colour appearing on the surface of the cloth.

A six-frame Brussels or Wilton jacquard could be made on exactly the same principle as a five-frame machine—*i.e.* so that the first five holes in each short row should form one group for operating six colours, and the

second five holes in each row to form another group. This arrangement would be quite satisfactory provided that all the carpets were of the six-

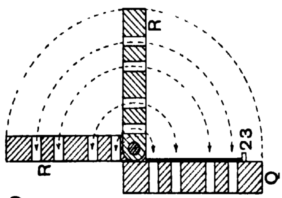


FIG. 94.

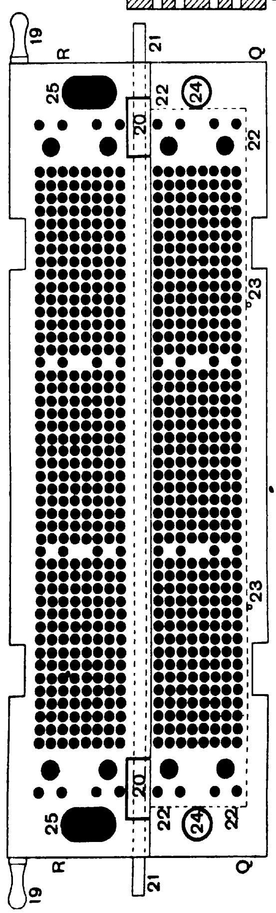


FIG. 93.

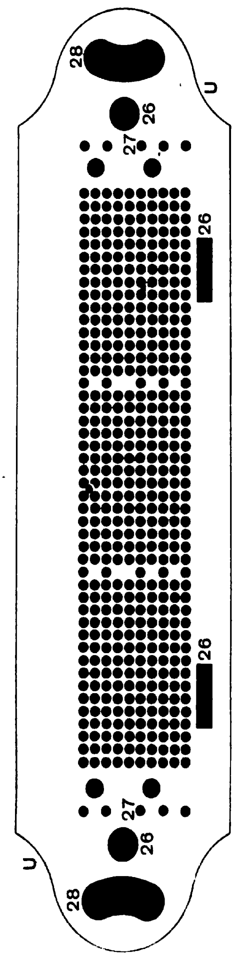


FIG. 95.

frame quality. If, however, both five-frame and six-frame qualities were required to be made in the same loom, some difficulties would arise with the

above arrangement. It is for the convenience of being able to make six-frame, five-frame, or any other quality in the same loom, usually the first two, that the needles of a six-frame jacquard are arranged as follows :

	1st Group, operating Odd Splits in Reed.	2nd Group, operating Even Splits in Reed.	Colour of Thread on Surface of Cloth.
Blanks opposite needles.	1	2	Controlling, say, blue threads.
	3	7	,, ,, red-brown threads.
	4	8	,, ,, orange threads.
	5	9	,, ,, drab threads.
	6	10	,, ,, sage-green threads.
	Five holes	Five holes	,, ,, scarlet threads

Each short row of the card would thus be made up of two sections or groups as above, and illustrated in Fig. 96.

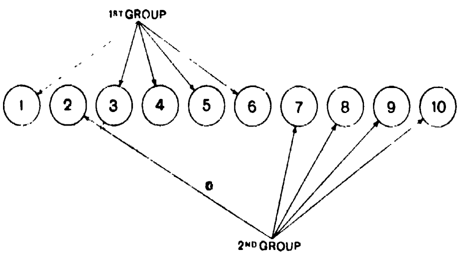


FIG. 96.

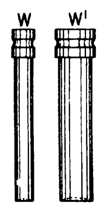


FIG. 97.

Blank opposite 1 or 2 means blue thread lifted in corresponding split.
,, ,, 3 ,, 7 ,, red-brown ,, ,, ,,
,, ,, 4 ,, 8 ,, orange ,, ,, ,,
,, ,, 5 ,, 9 ,, drab ,, ,, ,,
,, ,, 6 ,, 10 ,, sage-green ,, ,, ,,
Holes opposite 1, 3, 4, 5, 6, means scarlet thread lifted in odd split.
,, ,, 2, 7, 8, 9, 10 ,, ,, ,, even ,,

Returning again to Fig. 95, it will be observed that there are five holes in each row where the lacing holes are cut, but four only are used. The plate U, however, is made to enable cards to be cut for either a five-frame or a six-frame Brussels or Wilton. If the two bottom long rows in Fig. 95 be neglected, the holes would be identical with those in the plate, Fig. 93. When the plate is used for six-frame Brussels cards these two long rows are naturally utilised along with the other eight holes, and in two sections as explained above in connection with Fig. 96. The bottom hole in each row of lacing is also used, but the middle hole 27 is then omitted. The punches for the lace holes and for the peg holes are not disturbed unless a change is

made from a five-frame to a six-frame, in which case, of course, the middle one 27 only is moved to the edge, but the peg punches remain in the same position for both sets. The ordinary punches are altered according to the design, and in all cases the sizes of the punches are the same, and are similar to those shown at W and W^1 in Fig. 97. These have been drawn to a larger scale. In the plate U, Fig. 95, slots 28 are cut in the plate, and these serve the same purpose as the handles Z in Fig. 91.

The jacquard loom illustrated in Fig. 34 is a five-frame machine, and two of the frames, with their bobbins, can be seen distinctly behind the loom proper.

The reader will understand that Brussels carpet designs are practically identical in colour with the loops on the surface of the cloth, although cloths of different colours made from the same design may be, and often are, woven. The sizes of the small squares or rectangles in the design-paper are also proportionate to the number of loops in the width and the number of wires in the length of the cloth, and are usually the same size or approximately so. Consequently, Fig. 98, which is really a photographical reproduction of part of a five-frame $\frac{3}{4}$ Brussels carpet, may be taken to represent the design-paper. The full capacity of a jacquard for such a carpet embraces three sections, each of which is the same size as that represented by the card in Fig. 91 for operating 352 needles and 440 harness cords, or altogether 1056 needles and 1320 harness cords. Instead, therefore, of the full design there would be only one-third of that represented in Fig. 91 on the reading board. The full capacity of the machine provides for displaying 264 loops in a $\frac{3}{4}$ carpet; that shown in Fig. 98 contains 256 loops.

It will be seen that no weave of any kind appears in Fig. 98, and therefore none will appear on the design-paper; this is because the fabric is one of those special types for which it has been found advisable to construct special machinery—the mechanical parts of which operate the threads for the actual interlacing, with the exception of the pile threads on the surface, independently of the jacquard. In other words, the actual structure of the foundation of the carpet is simple, and is obtained by the use of tappets. (For illustrations of the structure of these and other carpets see pp. 394 to 414, *Textile Design: Pure and Applied*, by T. Woodhouse and T. Milne; Macmillan & Co., Ltd., London.)

Now in all such designs it will be evident that there are several successive rows of loops in the cloth, or colours on the design-paper, which differ little from each other, and when this is the case, and there is no weave to be considered, the plate machine is very efficient. There are, of course, plenty of changes to make in every design, and particularly so where horizontal lines or mixed effects appear, and both these types of ornament are prominent in Fig. 98.

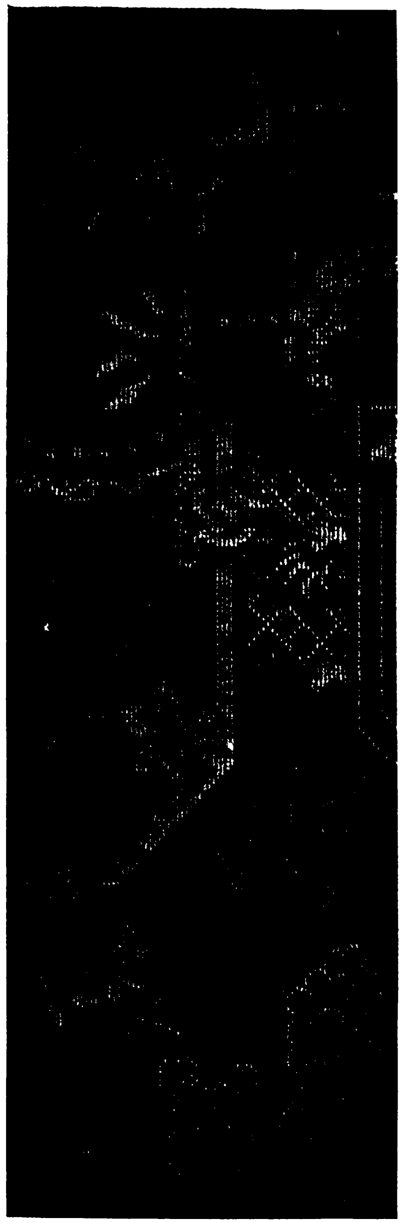


Fig. 98.

Two successive lines in an ordinary design may be exactly the same so far as the various groups of figuring threads are concerned, but since the weave almost invariably alters from one of these picks to the other, it is necessary to read the lines for both cards as if they were altogether different, and hence, except in the simplest ornament, there is no saving in time no matter how similar the figuring groups may be on successive threads. On the other hand, if two successive lines of a Brussels or Wilton carpet design are the same so far as the arrangement of the colour is concerned, there is no alteration to be made with the punches, and the two cards may therefore be cut quickly, and indeed simultaneously, as explained in connection with Fig. 92. In a similar way the various lines as a rule change more or less gradually, and when this is the case there may be very few punches to remove from the punch plate from line to line of the design. The plate machine is also made to act as a kind of duplicating or repeating machine. For this work the plates Q and R are made slightly different in order to be able to cut two cards at once.

Some years ago special gearing was added to the plate machine for the purpose of lifting off the punch plate U automatically, but several accidents resulted from the machines so fitted, and it was considered advisable to discard the special gearing. In some districts the carpet jacquards are arranged so that a hole results in a hook being lifted. The cutting is then rendered more simple, and the cards, having fewer holes, have not the same tendency to break.

CHAPTER VI

COMPARISON OF DIFFERENT PITCHES IN JACQUARD CARDS

WITH very few exceptions, the holes in jacquard cards are in perfect straight lines, although the size of the holes and the distance between each pair may vary according to whether the cards are intended to operate the needles in the so-called ordinary-pitch, medium-pitch, or fine-pitch machines. The division into the above three defined pitches is, however, not quite correct, for the change from the coarsest pitch to the finest pitch is pretty gradual; the definition, however, seems to be quite satisfactory in the various districts where two or more different pitches are in use, as it enables the operatives to distinguish between them. A few typical examples of cards of different pitches and different sizes of holes are illustrated in Figs. 99 to 105, and it will be seen that the decreasing pitch from the card in Fig. 99 to the card in Fig. 105 is more or less gradual. Table IV. supplies several particulars concerning the above seven kinds of cards, and also serves to demonstrate the diversity which obtains in this branch of weaving.

In every case in these examples the holes, which are often utilised for selvages, for simple tape weaves near the selvages of the cloth, and for other purposes which fall outside the scope of the actual figuring threads in the fabric, are omitted. When the weave for these selvage and other threads is complete on 2 or 4 picks, and the 4-sided cylinder makes a quarter turn every pick, it is a common and good practice to have the needles of the jacquard bent so that their ends may occupy a position in the needle board clear of the card, and therefore free from the control of the card. The four sides of the jacquard cylinder opposite these extra needles are drilled and the needles are operated from these rows. If tacks be driven into those holes, which in the ordinary way should be covered by blanks in the card, the heads of the tacks serve the same purpose as blanks, and hence any simple weave on 2 or 4 picks to the round can be arranged. The selvages or other simple parts are then clearly controlled independently of the jacquard cards. Instead of tacks, small wooden pegs may be used to block up the holes. If, on the other hand, the weave exceeds 4 picks to the round, or if

certain needles and hooks are required for special purposes—*e.g.* lifting the retaining catch of the uptake motion for crammed horizontal stripes, or for bringing the box motion into action—then it is necessary in most cases for these functions to be performed at some particular place or places in the

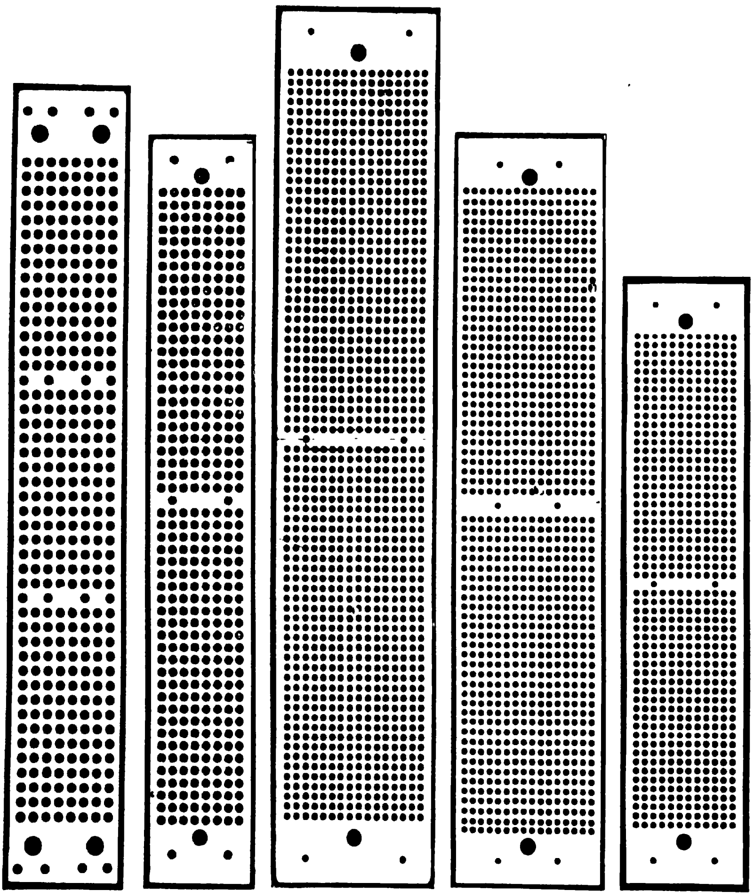


Fig. 99. Fig. 100. Fig. 101. Fig. 102. Fig. 103.

pattern, and hence the cards must be cut to operate these needles in the spare rows on the proper picks. These extra needles and hooks invariably occupy positions in the machine which are approximately in line with the same row as one or both of the peg holes in the cards in Figs. 100, 101, 102, and 103. In the card shown in Fig. 104 the same provision may be made

near the two outside peg holes, and, if necessary, also near the centre peg hole. As a matter of fact, in this particular case an extra full row of needles

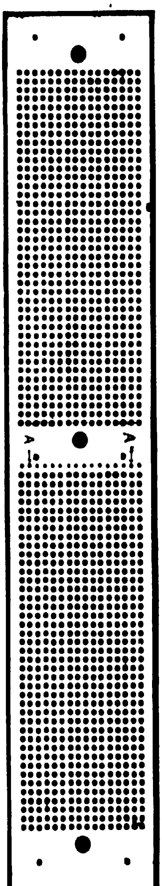


Fig. 104.

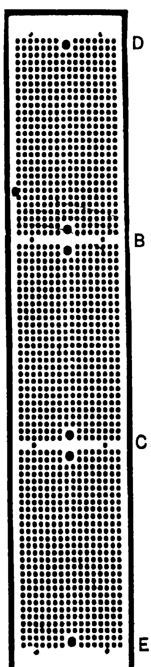


Fig. 105.

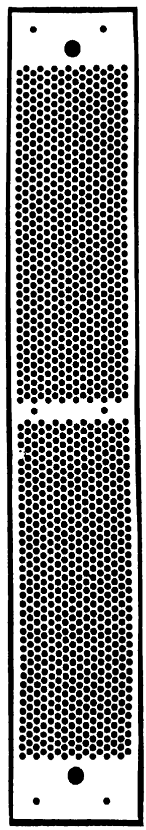


Fig. 106.

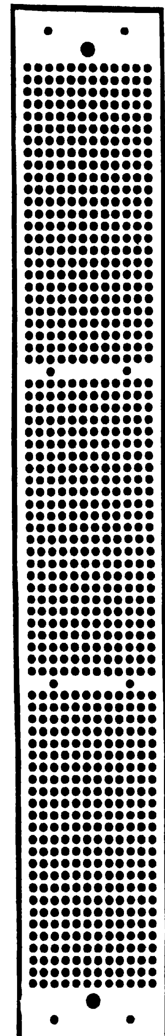


Fig. 107.

and hooks may be arranged opposite the row of small circles A mentioned in Table IV.

TABLE IV

Number of Card.	Pitch.	Type of Card or Machine.	Over-all Dimensions in Inches.	Particulars of Short Rows.	Total Capacity.	Pitch of Holes.
Fig. 99	Ordinary British.	5-frame Brussels carpet.	$17\frac{3}{8} \times 2\frac{1}{8}$	15 rows × 8=120 14 ,, × 8=112 15 ,, × 8=120	352 holes operating 440 hooks.	0·3125 in.
,, 100	Ordinary British.	400's jacquard.*	$16\frac{5}{16} \times 2\frac{7}{16}$	26 rows × 8=208 25 ,, × 8=200	408	0·2644 in.
,, 101	Medium British.	1200's jacquard.	$19\frac{1}{16} \times 3\frac{3}{16}$	38 rows × 16=608 37 ,, × 16=592	1200	0·2138 in.
,, 102	Medium British.	1040's jacquard	$16\frac{5}{16} \times 3\frac{1}{2}$	33 rows × 16=528 32 ,, × 16=512	1040	0·2045 in.
,, 103	Medium British.	660's jacquard.	$13\frac{1}{4} \times 2\frac{7}{8}$	28 rows × 12=336 27 ,, × 12=324	660	0·1942 in.
,, 104	Medium American and British.	1312's or 1328's jacquard.	$19\frac{3}{16} \times 3\frac{7}{16}$	41 rows × 16=656 41 ,, × 16=656	1312, or 1328 if row indicated by letter A is introduced.	0·1875 in.
,, 105	Fine Vincenzi and British.	1320's jacquard.	$14\frac{5}{8} \times 2\frac{3}{4}$	2 rows 14=28 24 ,, × 16=384 2 ,, × 14=28 Repeated 3 times.	440 × 3 = 1320	0·1555 in.

* The 600's card of the same pitch is the same length, but has 12 holes per short row instead of 8 holes, while the 900's card is the same width as the 600's but longer

The card illustrated in Fig. 105 differs from all the others in that all the extra holes in line with the six peg holes are utilised for figuring purposes. The omission of these 12 partially filled rows would naturally decrease the capacity of the machine by 168 needles—much too large a number to dispense with. At the same time, their introduction involves difficulties in other ways. The design-paper for use in connection with 16-row machines is usually ruled in vertical rows of 8, and such ruling is evidently quite suitable for the full rows of the card in Fig. 105. In the broken rows, however, there are only 14 holes, or two groups of 7, and it is clearly undesirable and practically impossible to leave two unpainted rows of small squares in every 16, or one in every 8, on the design-paper to allow for the two needles and hooks missed in each row. In each of the two sections marked B and C there are 4 rows × 14 per row = 56 holes, and although the design-paper is ruled in 8's, and the design painted in the usual way, the 7 blocks of 8 on the design-paper which correspond with these 56 holes are re-ruled into 8 blocks of 7. Similarly, $3\frac{1}{2}$ blocks of 8 would be re-ruled into 7's for the two sections D and E, commencing with a half block, so that the last 7 would finish on a heavy line and join up perfectly with the full rows. The design-paper would contain altogether the equivalent of 165 blocks of 8 if all the needles of the machine were in use. Thus

$1320 \div 8 = 165$ full blocks; but arranged

Half block	=	4
164 full blocks	=	1312
Half block	=	4
		1320 needles.

Figs. 86 and 87 illustrate the headstock of the piano machine in which the card illustrated in Fig. 102 was cut. As already mentioned in the description of the above headstock, it is a difficult matter to control 16 keys, and hence the process of cutting is slow. Thus

700 to 800 cards per day may be cut from common harness designs;
500 „ 600 „ „ full harness designs;

but only about 200 per day can be cut on the 16-row machines from full harness or brocade designs unless the cutter has had considerable experience and the design is a simple one. In certain instances where it has been found economical to use a 16-row machine the card has been cut in two distinct operations—*i.e.* one half the card from end to end cut with 8 keys and 8 punches, and then the second half of the card cut with an adjoining set of 8 keys and 8 punches. In this case it would be necessary to read alternate blocks in the design-paper for each section—odd blocks for one section and even blocks for the other. This departure from the ordinary method of cutting a complete row, or all which are required to be cut in a complete row, had for its object the simplification of operating the keys, and for the same reason there is still a tendency on the part of several firms to adhere to the 12-row machines, and so employ a number which can be conveniently and quickly operated. The card in Fig. 103 illustrates one way of utilising this number for a 660's machine, and there are others. One machine, which works splendidly, contains 900 needles, with the usual extra needles, if desired, in line with the pegs—say 916 needles in all, and arranged as under:

38 rows × 12 per row . . .	=	456
37 „ × 12 „ . .	=	444
2 broken rows × 8 per row . .	=	16
		916

The card measures 17 in. by 3 in., and the pitch of the holes and needles is the same as the corresponding values for the card in Fig. 103.

The various kinds of cards and pitches illustrated in Figs. 99 to 105 provide a great range, and one would scarcely think that there was room for any others. Nevertheless several others have been introduced, and these include not only the straight-lined arrangement as illustrated in the

above seven examples, but also the zigzag arrangement. The chief features in the latter are

1. The fact that the unique distribution of the holes minimises the danger of breaks in heavily punched cards ; and
2. That space is utilised to the best advantage.

On the other hand, the arrangement necessitates slight structural alterations in the jacquard, and complicates considerably the card-cutting machine.

The general distribution of the holes in the card is illustrated in Fig. 106, and a 12-row card for a 900's ordinary British pitch jacquard is shown in Fig. 107, so that the two may be compared.

Card in Fig. 106 : 38 rows × 16, or 76 rows × 8 = 608
38 „ × 16, „ 76 „ × 8 = 608

1216

1216 needles for an 18 in. × 3 in. card ;

$$\text{or } \frac{1216 \text{ needles}}{18 \text{ in.} \times 3 \text{ in.}} = 22\cdot519 \text{ needles per sq. in.}$$

Card in Fig. 107 : 25 rows × 12 per row = 300
25 „ × 12 „ = 300
25 „ × 12 „ = 300

900

900 needles for a 23 in. × $3\frac{1}{2}$ in. card ;

$$\text{or } \frac{900 \text{ needles}}{23 \text{ in.} \times 3\frac{1}{2} \text{ in.}} = 11\cdot18 \text{ needles per sq. in.}$$

CHAPTER VII

ZIGZAG CARD-CUTTING MACHINE FOR STIFF PAPER CARDS AND POWER CARD-CUTTING MACHINE

FIGS. 108 to 110 illustrate one type of piano-machine headstock for cutting the zigzag rows similar to the card in Fig. 106. The method of fixing the headstock to the cross-bar is exactly the same as that adopted in other piano machines — *i.e.* the cross-bar is placed on the screwed rods A, Fig. 108, between the nuts B, and the latter are then arranged to hold and to lock the cross-bar in its proper position. Figs. 109 and 110 show clearly that there are 16 punches arranged in two rows —the second set D of 8 being placed midway between those of the first set C, and, of course, in a different horizontal plane. The chief difficulty in cutting cards in such a machine is that of controlling the keys, for 8 ordinary keys E have to control the 16 punches C and D. An ordinary key F operates the punch G for the peg hole. The cap H, Fig. 108, and the upper plate J, are removed in Figs. 109 and 110 in order that all the essential parts may be exposed to view. A groove is cut in the lower

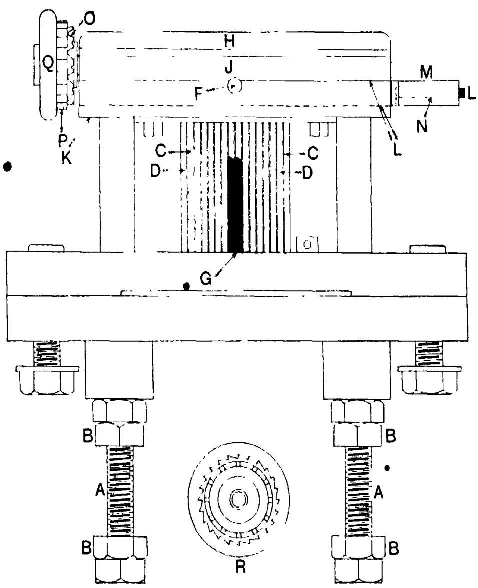


FIG. 108.

rectangular plate K to admit the sliding bar L. Eight grooves are cut in the upper part of this bar, and the ends of the keys E are entered into these grooves. The right-hand end of the rectangular plate L is turned down and passes through a hole in the bracket M fixed to the headstock. On this circular part of L is placed a spring N, which always tends to keep the plate to the left, with its extreme rounded left end pressing against the cam O. This cam is circular, and is compounded with ratchet wheel P and hand-wheel or disc Q. A view of these parts, looking towards the left in Figs. 109 and 110, is shown detached at R in Fig. 108.

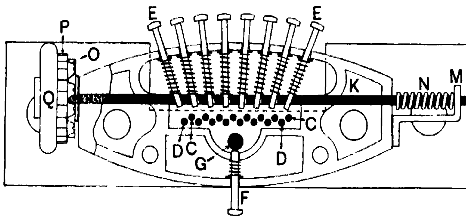


FIG. 109.

The face of the cam O consists of alternate shallow and deep recesses, and in Fig. 109 the rounded or pointed end of plate L is in one of the deep recesses, and hence the plate occupies the extreme left-hand position with the ends of keys E pointed towards the second row of punches D. On the other hand, in Fig. 110 the end of plate L is in one of the shallow recesses, and consequently the plate L is in the extreme right position, with the spring N compressed and the ends of keys E pointed towards the first row of punches C. The latter view represents the position of the keys E when the actual cutting is commenced. The card-cutter presses in those keys E which represent the painted parts in the first block of 8 on the design-paper, so as to place the ends of the keys over the respective punches C, and presses down the right treadle in the usual way. He or she then presses down the left treadle, which causes the headstock to rise, and as the latter rises, one of the teeth of the ratchet wheel P comes into contact with a fixed pawl, not shown, and thus the compounded parts O, P, and Q are rotated through $\frac{1}{24}$ of a revolution. In doing so the gradient of the cam allows the spring N to force the plate L to the left, and to carry the extreme rounded end into the lower part of one of the deeper recesses as illustrated in Fig. 109. This naturally carries the keys opposite the punches D, when a similar

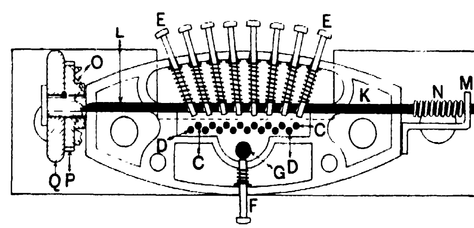


FIG. 110.

downward movement of the right treadle, with the correct keys pressed in to correspond with the painted part of the second block of 8 in the design-paper, causes the required holes in the second row D to be cut. It will thus be seen that the plate L, through the medium of the parts N, O, P, and Q and the fixed pawl, carries the keys E first to left and then to right for each pair of short rows C and D. Now, it is evident that since there are two sets of punches C and D to be operated at different times, the carriage will require to move only every second tramp of the left treadle, and not every tramp as in the ordinary machine illustrated in Fig. 68. This being so, the left treadle (see J in Fig. 68) must not be connected directly with the handle Z by rod Y, otherwise the carriage would move every tramp of the left treadle. For the zigzag pitch machine an upright catch or pulling pawl is attached to the left treadle, and this catch comes into contact with a 6-toothed or 8-toothed ratchet wheel, supported by and free to rotate on a cross-shaft, every time the left treadle is depressed, rotating the ratchet wheel one tooth at a time. Compounded with this ratchet wheel is a 6 or 8 to the round cam, the outline of which consists of alternate projections and recesses; these parts are presented successively to a special lever attached to handle Z by a rod similar to Y. One or other of the three or four projections comes into contact with, and depresses, this special lever every second tramp of the left treadle, whereas on the other tramps the recesses come opposite the lever to allow it to rise through the influence of a spiral spring and thus enable the handle Z to occupy its highest position.

Even at its best it will be evident that the smooth working of the parts, and particularly that of the cam O, Figs. 108 to 110, against the end of plate L is difficult to achieve. All the keys are on the same level, and so are the tops of the punches C and D, so that very accurate adjustment is necessary to obtain correct results.

Another method is illustrated more or less diagrammatically in Figs. 111 to 117. Fig. 111 is an inside elevation of the eight keys E, the part T being a horizontal projection from the inside face of the key; Fig. 112 is a plan of the 8 keys E together with 16 supplementary keys R and S in two planes, and the disposition of the 16 punches C and D; the large black circle is the peg-hole punch. Figs. 113 to 117 illustrate the action of the stem T of the keys E on the supplementary punches R and S. In this machine the two sets of punches C and D are operated by two distinct sets of supplementary keys R and S, each pair of which is in turn controlled by a single key E. There are thus only eight keys E for the cutter to operate. In this arrangement the keys E are provided with a projecting part T, and it is the end of this part T which operates alternately the upper and lower supplementary keys R and S. It will thus be seen that the keys F must rise and fall alternately in order that the parts T may be brought opposite to the two

sets or rows of supplementary keys R and S. The mechanism for imparting this up-and-down motion to the keys E is not shown, neither are the brackets for supporting it shown. It will be understood that the keys E, as well as the supplementary keys R and S, will require springs for returning them to their normal positions whenever the former are released by the fingers.

The two positions of the keys are illustrated in Fig. 113, while Fig. 114 shows three positions :

1st. Key E pressed in, and supplementary key S forced over punch C;
2nd. Key E pressed in, and supplementary key R forced over punch D;
3rd. Key E and supplementary keys R and S out of action.

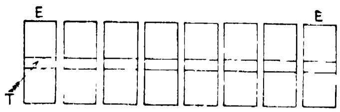


Fig. 111.

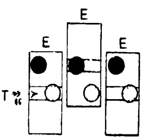


Fig. 113.

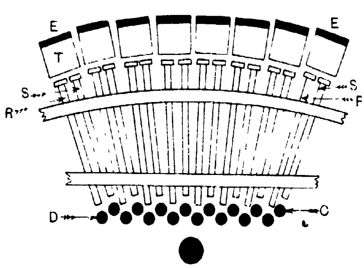


Fig. 112.

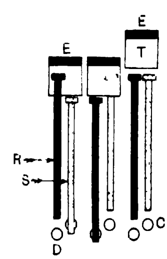


Fig. 114.

It will be understood that supplementary keys R and S cannot be pushed forward at the same time. For the first action, the supplementary keys S will be pushed over the punches C, while in the second action the supplementary keys R will be pushed over the punches D. Both actions are illustrated in Figs. 113 and 114.

Fig. 115 illustrates the part T of a key E as having pushed a supplementary key R over its punch D, while Fig. 116 shows the same key E with its part T in contact with a supplementary key S, the end of the latter being over its punch C. An end view of the parts R, S, D, and C appears in Fig. 117.

The treadles of all the foregoing piano card-cutting machines are operated by the card-cutter's feet, in short, the machines are so-called hand-power or foot-power piano machines. The one illustrated in Fig. 118

is also operated in the same way. The latter is an American type, and it

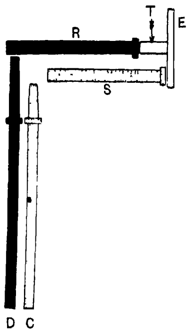


FIG. 115.

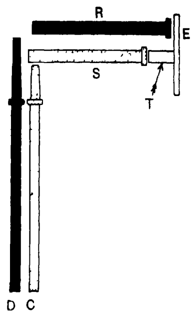


FIG. 116.

FIG. 117.

will be seen that the straight edge is moved from line to line by means of the central hand wheel, the long horizontal shaft, and the two pairs of bevel wheels in connection with the upright screws. The machine is provided with adjustable foot-pedals or treadles to make the power applied suitable for the cutting of thin or thick cardboard cards, or to enable two cards to be cut simultaneously, one below the other, for two different sets. Otherwise the machine differs only slightly from the English make illustrated in Fig. 67.

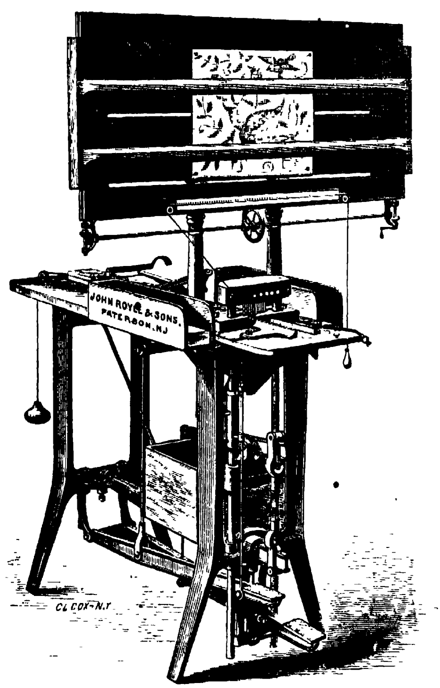


FIG. 118.

Such machines, however, are occasionally driven by power, and Fig. 119 represents a machine so driven. The framework is constructed to suit this method of driving, but the usual treadles are retained; they are used solely, however, to apply and disconnect the power. One treadle is used to

connect the friction-clutch attached to the fly-wheel to start the machine, while the other treadle is employed to disconnect the friction-clutch in order to stop the machine. The treadles are easily and quickly controlled; indeed this is necessary, because the eye and the fingers determine the moments for the punches to act.

Both foot-power and power-driven machines are made to cut cards from 100's to 900's jacquards of the French index, but arrangements may be made to cut 1200's cards when desired, as well as cards for the fine-scale 1304-needle jacquards.

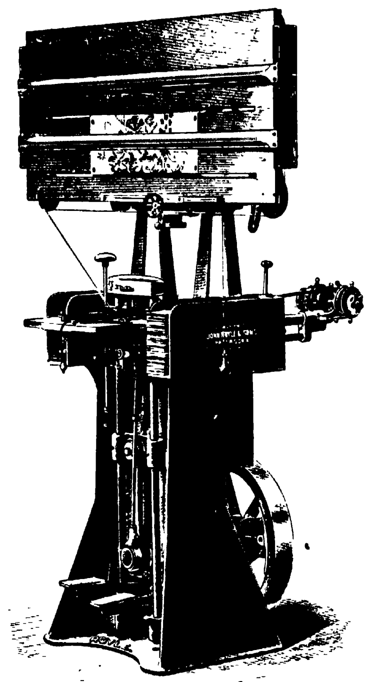


FIG. 119.

Accessories. — Mistakes often appear in the various sets of cards; in some cases holes are found where blanks should be, and *vice versa.* The holes which are not wanted are often blocked up with the small discs which have been punched out of the cards; the part may then be glued so that the disc will not be pushed into the cylinder by the needle of the jacquard, or perhaps a glued piece of strong tough paper may be placed over the defective place. Special patented attachments may be had for the same purpose.

On the other hand, when extra holes have to be punched at those places missed during the punching operation, these holes have to be made in the otherwise perfectly perforated cards by special types of punches provided with long jaws capable of reaching at least to the centre of the short row of the widest card in use. A handy punch for the purpose is illustrated in Fig. 120, its chief feature being the fact that the punch-holder is made of a size to facilitate the correct selection of the point at which to punch the required hole. In the illustration the under part of the jaw is below the cards, and the punch is operated, as demonstrated, by a lever.

Another type of single-hole puncher for the same purpose, and one which is largely used, is that illustrated in Fig. 121. There are also

modifications of this, and in each case different punches are provided to suit the size of hole required.

Although the different pitches and methods of cutting cards made from comparatively stiff cardboard already described do not exhaust all the systems and kinds in use, the former serve to demonstrate the great diversity of pitches and the many attempts which have been made to economise in the use of paper. And this attempt at economy is quite independent of that which is so successfully accomplished with regard to special jacquards. With the present rapid changes of style and demands in almost all branches of fancy weaving, it is the exception rather than the rule for a set of cards to be completely worn out; hence the full value of the cards in such a set is not obtained, and the expenditure in cards is naturally raised. Even in those cases where a successful run on any particular design continues until the cards are pierced by the pressure of the needles, by the pegs or pivots, and otherwise damaged until they are no longer fit for service, the cost of cards is a serious item. It may perhaps be argued that an inferior quality of card should be used for those sets which are not expected to be utilised for a considerable time; but such expedients for the sole purpose of cheapness often prove to be false economy. A changeable climate such as that which obtains in this country affects the cards considerably, and if there is any shrinkage or expansion in the cards, differing, as they invariably do, from the corresponding infinitesimal alterations in the pitch of the needles, it is quite evident that the holes in the cards will no longer coincide with the points of the needles, and hence faults will appear in the cloth causing damages if they are not removed, and waste as well as decreased production if they are removed.

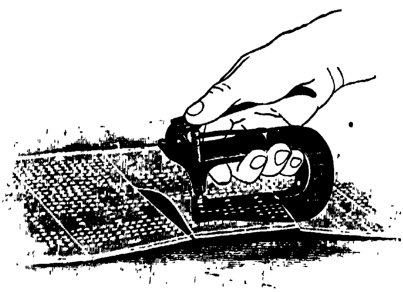


Fig. 120.

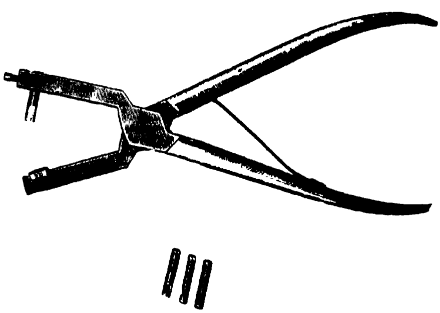


Fig. 121.

Cards made from a common quality of paper usually expand much more in damp weather than do similarly sized cards of a better make, and one of the methods employed to test the value of cards with respect to their power of resisting the action of a humid atmosphere is to soak a sample of each kind in water, and then compare their lengths with unsoaked cards of the same quality, or with the actual lengths of the cards measured before soaking. The better-class cards are, in general, affected the least, and for this reason many firms prefer to use them in preference to employing the cheaper grades. The weights of cards for the same machine will obviously vary, partly on account of their solidity and the material from which they are made, and partly according to their thickness. And it is only natural to expect that the degree of expansion will not only be influenced by the quality of the paper, but also by the thickness of the card, and to some extent by the nature of the raw material. The following table should prove of some value to those interested in this branch, as it represents observations made on six different kinds of jacquard cards for use on 600's machines :

Number of Card.	Average Number of Cards per Lb.	Length in Dry State.	Length after 30 Minutes' Immersion.	Increase in Length.
		In.	In.	In.
1	11·55	$16\frac{7}{32}$	$16\frac{15}{64}$	$\frac{1}{64}$
2	11·65	$16\frac{1}{4}$	$16\frac{5}{16}$	$\frac{1}{16}$
3	12·34	$16\frac{1}{4}$	$16\frac{5}{16}$	$\frac{1}{16}$
4	13·03	$16\frac{9}{32}$	$16\frac{3}{8}$	$\frac{3}{32}$
5	14·13	$16\frac{9}{32}$	$16\frac{5}{16}$	$\frac{1}{32}$
6	14·34	$16\frac{7}{32}$	$16\frac{9}{32}$	$\frac{1}{16}$

Card No. 1 is the most expensive of the six kinds, and hence, from the point of view of resistance to change of length when under the influence of moisture, is likely to give the best satisfaction. On the other hand, it will be observed that it is the heaviest card in the lot, and would therefore prove costly, but it might, nevertheless, resist the action of the needles as well as the weather much better than any of the others, in which case it would probably be even more economical if the cards are likely to be used until they are unfit for the work. For resistance to wear and tear, it is a good plan to compare the value of cards by using a few of one kind along with others in the same set.

A few remarks concerning the approximate cost of making a design and performing all the subsequent operations required preparatory to actual weaving will show conclusively the important part which the cost of cards plays in actual manufacture with respect to the other requirements. No actual or definite price can be fixed with regard to the original sketch for any given size of cloth, nor even for a given size of sketch. Altogether apart

from the size of the sketch, its price will be obviously influenced greatly by the status of the designer, and in a lesser degree by the circumstances which demand or prompt the creation of the design, by the amount of detail which appears thereon, and by the class of fabric upon which the design is intended to be displayed. On the other hand, more or less uniformity in prices obtains for all succeeding operations, although even here differences obtain according to circumstances and skill. It is therefore quite impossible to reduce the actual cost to a common level. It is equally impossible to obtain an actual standard cost of production in those cases where manufacturers employ their own designers, although each firm may clearly be able to make a near approximation to its actual expenditure with respect to the number of sketches produced in a given time. When, however, a manufacturer buys his sketches and point-paper reproductions ready for the card-cutter, there is always a definite charge which can be placed alongside the cost of cards, card-cutting, lacing, lacing twine, wires, and wiring. In certain cases a definite amount is paid for the sketch, and then the transference to point-paper is usually paid by the number of square hundreds of small blocks. Thus, a design on 300 threads and 300 picks contains: $3 \times 3 = 9$ square hundreds. Similarly, a design on $400 \times 400 = 16$ square hundreds, and a design on $600 \times 600 = 36$ square hundreds, and so on.

The same sketch, although not suitable for reproduction in all sizes, can often be used for more than one size of design, and in many cases a sketch which is intended to be reproduced on a small number of square hundreds may be much more complex than a sketch which has been made for reproduction on a very large number of square hundreds. There are thus very satisfactory reasons why the sketch, under certain circumstances, should be sold independently of the point-paper design. And in many instances somewhat similar conditions necessitate a departure from otherwise standard prices with reference to the painting of the point-paper design.

For example, a point-paper design on 600 threads and 600 picks made from a sketch intended to be reproduced in a fancy silk, cotton, or worsted fabric may require a large number of different weaves—sometimes intricate ones—in the ground and figure, whereas the point-paper design made from a somewhat similar sketch designed for a linen table damask to be woven by a twilling jacquard loom may be altogether devoid of weave structure, and even if shading or medium shades are introduced into the latter design the amount of work per square hundred on the design-paper will be much less than the corresponding work on the area for the silk design. Moreover, in the case of the design for the above-mentioned silk fabric there may be only one sheet of 600 threads and 600 picks, or 36 square hundreds, whereas the point-paper design made from the sketch for the fine linen damask may consist of anything up to nine large sheets, or even more, each sheet

containing from 600 threads and 600 picks to 600 threads and 900 picks. That is, $6 \times 6 \times 9 = 324$ square hundreds in the first case, and $6 \times 9 \times 9 = 486$ square hundreds in the second case.

The conditions appertaining to the silk fabric are more or less general with respect to several other types of fabrics—*e.g.* tapestries and the like. It will thus be seen that whatever be the price paid per square hundred there is a considerable difference between the areas, and that in those cases where a large number of design sheets are required from the same sketch, it becomes a feasible plan to include the sketch in the price paid per square hundred for painting the design for a common harness, or for painting and twilling for a full harness or brocade design. Except in special circumstances, the price per square hundred to include sketch, paper, painting, and twilling for linen damasks, quilts, and similar goods where no weaves, or at the most simple weaves, are required, varied in pre-war times from 10d. to 2s.[1] Hence, if we take the comparatively low price of 1s. per square hundred, the cost for 100 picks of a 600's design will be 6s.

Let us suppose that a good class card, say at 3d. per pound, is used for such a design, and that there are approximately 11 cards per pound as in No. 1 in the above table. We should have

$$\frac{100 \text{ cards}}{11 \text{ per pound}} = \text{approximately } 9 \text{ lb.},$$

and 9 lb. × 3d. per pound = 2s. 3d., actually more than one-third of the total cost of designing, painting, and twilling. And if the cards are only 2d. per pound and the same weight, the cost of cards alone is one-quarter that of the designing. It is only fair to mention that many firms use much lighter cards, say about 16 to the pound. In addition to this cost of cards there is the remainder of the work tabulated as under:

	s.	*d.*
600's machine: 100 cards	2	3
Cutting for 100 cards	0	8
Lacing for 100 cards	0	3
½ lb. lacing twine	0	9
	3	11

It need hardly be mentioned that there are very good reasons for the many attempts which have been made to substitute very thin paper for the well-known stiff cards, for by the use of the former a much less weight of paper is used, and all lacing and wiring, with the necessary materials, are dispensed with.

Fig. 122 illustrates this thin paper, which is cut for use on the Verdol

[1] Please note: since prices are not yet settled, all items below are pre-war values.

machine, such as that illustrated in Fig. 363. Two fully cut cards, or their equivalent, are illustrated in the upper figure, and two partially cut cards in the lower figure. The capacity of the machine for these cards is repre-

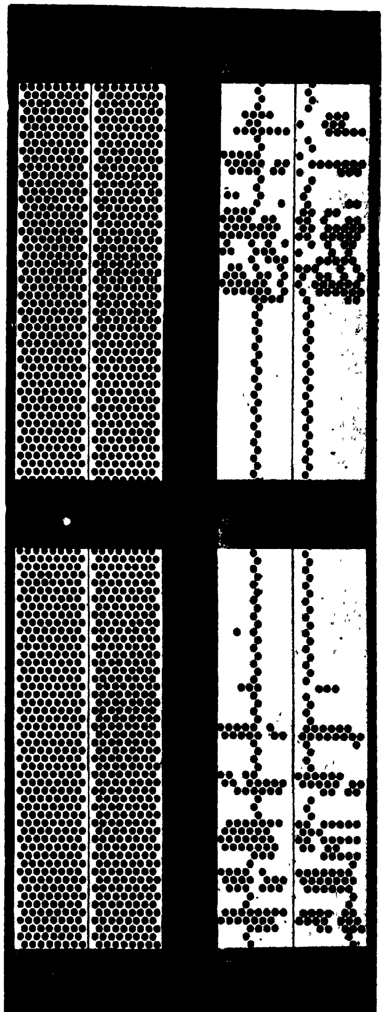


Fig. 122

sented by 896 needles and hooks, and the paper for the equivalent of one card is less than one-fifth of the area of the 900's card illustrated in Fig. 107; when the thickness of the two is taken into consideration, the actual volume

of the 896's card or paper is naturally very much less than one-fifth of the volume of the 900's card. Without comparing the practical value of the two pitches and systems so far as working the machine, it will be seen that with regard to material there is a considerable saving effected when the thin paper is used, and besides this it will be clear that the space required for the storage of ordinary cards not in use will be very much greater than that required for the same number of sets of the fine pitch paper cards or paper lengths. Moreover, since the paper is in lengths, it will be obvious that no lacing or wiring is necessary, and hence a great saving is effected in these materials.

The advantages, however, are not by any means all on the side of the paper lengths. This thin paper is very easily torn; is difficult to cut; must be very accurately arranged on the cylinder because of the fineness of the pitch; and, as may be imagined, is very much more susceptible to atmospheric conditions than are the stiff paper cards which are so largely used. Provision is, however, made to effect the turning of the cylinder with a minimum amount of danger to the cards, and it is usual to take observations of the average temperature and humidity in those places where the fine pitch paper is to be used, and to prepare the paper, chemically or otherwise, so that it may be affected as little as possible.

The parts of the card or paper which are subjected to the greatest stress and wear are those where the rotating pegs of the Jacquard cylinder enter the large holes for the purpose of drawing the paper round, and these parts are invariably strengthened by an extra strip of tough paper, about $\frac{3}{8}$ in. wide, and fixed to the broad band of paper. These strips are shown clearly in Fig. 122 by the three dark bands—one at each side, and one in the middle.

CHAPTER VIII

FINE PITCH PIANO CARD (PAPER) CUTTING MACHINE

FIGS. 123 to 126 illustrate one type of machine which is used for cutting the continuous lengths of paper to be used on the Verdol jacquard. Fig. 123 is a sectional elevation; Fig. 124 is a plan of the keys and connecting levers; Fig. 125 is an elevation of the machine; while Fig. 126 is a plan partly in section. Previous to placing the length of paper A, Fig. 123, on the peg wheels B, it is passed through a special peg-hole cutting machine, so that the holes in the three positions shown in the uncut card or paper at the bottom of Fig. 124, or the four positions in the similar but larger uncut card at the bottom of Fig. 126, may be caught by the pegs or studs of the peg wheel B and rotated when necessary. The jacquard machines are made with one, two, three, or more sections of 448 needles each, so that the cards illustrated detached in Figs. 124 and 126 represent respectively:

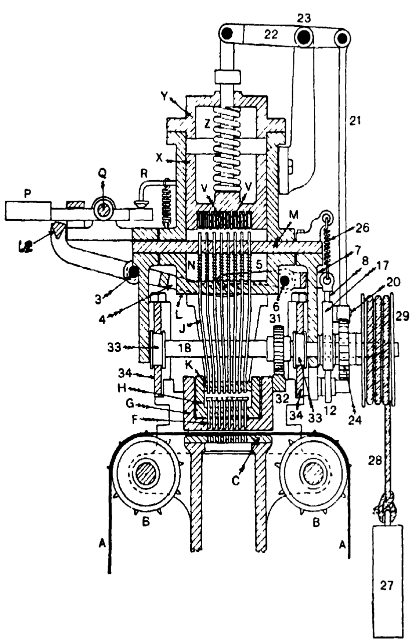


FIG. 123.

448 × 2 sections = 896 needles and hooks.
448 × 3 „ = 1344 „ „

These cards are not drawn to scale, but the actual size of the two-section card is $12\frac{3}{4}$ in. (32·4 cm.) long and $1\frac{1}{16}$ in. (2·725 cm.) broad, and the pitch in all cases is 0·1009 in. The length of the paper A, Fig. 123, would be in one sheet, and would naturally be long enough for the total number of picks in the pattern to be woven, in addition to a sufficient length at each end to facilitate the starting and finishing of the card, and to enable the two ends to be joined satisfactorily when the cutting operation is finished. Long lengths of paper may be prepared with the peg holes cut, and these lengths rolled tightly on a wooden roller and placed in a convenient position under the peg wheels B. When once placed in position on these peg wheels it remains stationary until all the holes for the pattern have been cut in one card. In this way it differs from the ordinary cards in the piano machine and in other types of fine-pitch machines, where the card moves after each short row or two short rows have been cut.

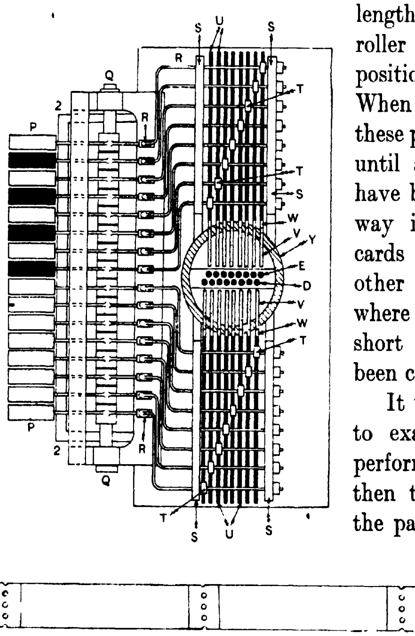


FIG. 124

It will be a convenient plan first to examine the mechanism which performs the actual cutting, and then to consider the movements of the parts which permit of the intermittent movement of one part of the cutting mechanism with respect to the fixed position of another part of the cutting mechanism. For this purpose we will examine Figs. 123 and 124. The bottom plate C shows one row of holes, which corresponds, say, to the first row in the card; the holes are similar to, but smaller and more closely set than, the row marked D in Fig. 124. Immediately behind these eight holes in plate C, but situated a little to the right for the purpose of obtaining the zigzag pitch, are other eight holes which bear a similar resemblance to, but again smaller and more closely set than, the row marked E, Fig. 124. Rows of short punches F, Fig. 123, with suitable heads pass through the two channels G and H, and their cutting ends rest upon the paper card A just before the actual cutting takes place. In the drawing these punches are shown lifted clear of the paper in order to show all parts more distinctly.

After the selection of needles or punches has been made, one, two, or more of the short punches F are forced through the paper A by means of the downward movement of the long punches J, which are guided in their up-and-down movements by holes drilled in the plates K, L, and M, and are returned, after having operated the desired punches F, by means of the springs N. At this time it will be clear that some of the punches F will have their ends through the paper, but this does not affect the continuation of the process. As a matter of fact, it is an advantage for these punches to remain in the holes until every row in the card has been cut. There are just as many short punches F in the plate or inner channel H as there are needles in the machine for which the card is intended, and the punches help to keep the paper in its correct position. A second row of eight punches is required for the alternate rows E, Fig. 124, and one of these is shown at O, Fig. 125. Two rows, one of D and one of E, are cut at the same operation.

We will now consider the mechanism by means of which the long punches or needles J in Fig. 123 and O in Fig. 125 are selected according to the design. There are 16 short punches F and 16 long punches J and O required for the two rows of holes D and E, and each punch J and O has its own particular key by means of which the card-cutter selects the proper ones. These 16 keys are shown at P in Fig. 124, and one of them in Fig. 123; for the convenience of the reader the keys in Fig. 124 are represented by different colours, and the same or similar arrangement might be adopted for the convenience of the card-cutter. In our illustration we show

1 white key 1 black key	for 8 keys to operate rows E.
1 white key 1 stippled key	„ 8 „ „ D.

With some such arrangement the selection may be made with the maximum of ease, and with few mistakes. The selection at the best is, of course, a slow process, as is usual with all cases where several from 16 keys have to be chosen at once, but two successive keys may be operated by one finger when it is necessary to have more than one-half out of each group depressed. Each key P, Figs. 123 and 124, is fulcrumed at Q, and upon its inner arm rests a lever R, bent as shown, and supported by the two frames S. Fixed to each of these rocking levers R, and between the plates S, is a pendent lever T, the curved lower end of which fits into a suitably shaped recess in the sliding rod U. A second series of sliding bars, which we may call supplementary bars, is shown at V in Figs. 123, 124, and 125. To the inner ends of sliding bars U are fixed small angle-irons W, Fig. 125, and from the horizontal part of each angle-iron depends a pin which passes through a corresponding hole in the end of the supplementary sliding bar V. It will thus be seen that the supplementary sliding bars may move

vertically up and down when desired in virtue of the pin connection, and since the two bars U and V are coupled together by means of W and the pin, it follows that they move in unison in the horizontal direction.

The downward action of any of the piano keys P will consequently raise

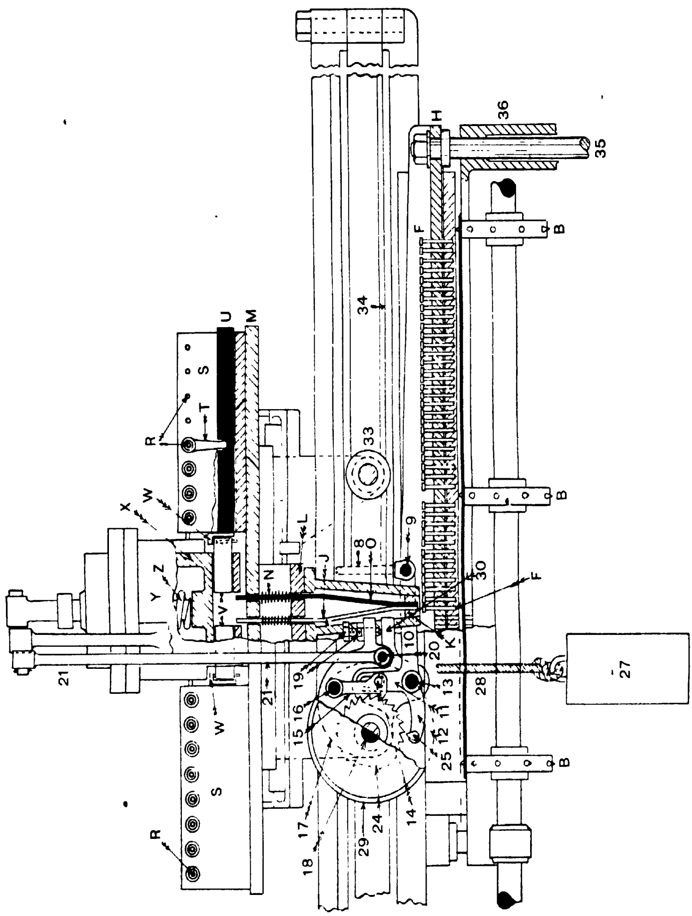


Fig. 125.

the inner end of the key, and also the end of lever R, Fig. 123; the straight part of R between the plates S will therefore revolve slightly and sufficiently to enable the lower end of the lever T, Fig. 125, to push forward slides U and V, and hence to place the end of supplementary slide V over its corresponding long vertical needle or punch J or O. The supplementary slides V are situated in slots at the base of the plunger or piston X, enclosed in

cylinder Y, and depressed, when facilities are offered, by means of the pressure of spiral spring Z between the lid of the cylinder and the central part of the plunger. The normal position of the piston X is up, but when the required number of supplementary slides V have been pushed into the active position—*i.e.* over one or more of the long punches J and O—the piston X is liberated and is forced downwards by the spring Z; the lower face of the piston in turn forces the long punches J and O down against the heads of the short punches F, and the cutting ends of the latter are consequently forced through the card or paper A at those points which represent the corresponding painted squares of the design-paper.

We may now examine the remaining parts of the mechanism which are also under the influence of the piano keys P. In Fig. 126 these keys are omitted entirely in order to expose more clearly the mechanism which is situated underneath and operated directly by the downward motion of any of the keys. A rectangular framework 2 is fulcrumed at 3, Figs. 123 and 126, and from the back part of the frame projects an arm 4; at the extreme rear end of arm 4 rests a similar arm 5, fulcrumed at 6, and prolonged at 7 in order to be attached to the end of a vertical rod 8. The lower end of rod 8, Fig. 125, is attached at 9 to a three-armed lever 10, 11, and 12, fulcrumed at 13. The vertical arm 11 contains a slot into which is passed a pin 14 projecting from the side of the hanging catch 15, fulcrumed at 16, near the edge of an arm 17. The arm 17 rotates on the shaft 18, which passes through the machine. The free end of arm 17 is provided with a set-screw and lock-nuts 19, while to a pin 20, which projects from the side of the arm 17, near its end, is placed a rod 21. The upper end of rod 21 is attached similarly to the short arm of 22, Fig. 123, fulcrumed at 23.

When any of the keys are depressed, the rectangular frame 2 rotates slightly about its fulcrum 3, its arm 4 is elevated, and so is arm 5, fulcrumed at 6. Consequently the short arm 8 descends slightly, and this action causes the three-armed lever 10, 11, and 12, Fig. 125, to rotate slightly clockwise about its fulcrum 13. When this happens, the pin 14, which is under the influence of the slot in the upper part of arm 11, is drawn to the right, and this naturally causes the pawl of hanging catch 15 to turn about its fulcrum 16, and to withdraw the pawl from contact with the teeth of the ratchet wheel 24, on shaft 18. At the same time it will be seen that the small pawl 25, on the end of the arm 12, will enter the teeth of the ratchet wheel 24, and thus prevent any movement of the latter for the moment, which happens to be the time when part of the card is being punched.

In the positions shown in Fig. 125 it will be seen that since the hanging catch 15 has its fulcrum on the side of lever 17, and its pawl in contact with one of the teeth of the ratchet wheel 24, the rod 21 is held securely for the time being in its lowest position, and hence the spring Z, Fig. 123, cannot

move the block X downwards. The withdrawal of the hanging catch pawl 15 by means of pin 14, due to the partial rotation of the three-armed lever 10, 11, and 12, however, releases the lever 17, and consequently enables the spring Z to force down the block X, and so force the short punches F through

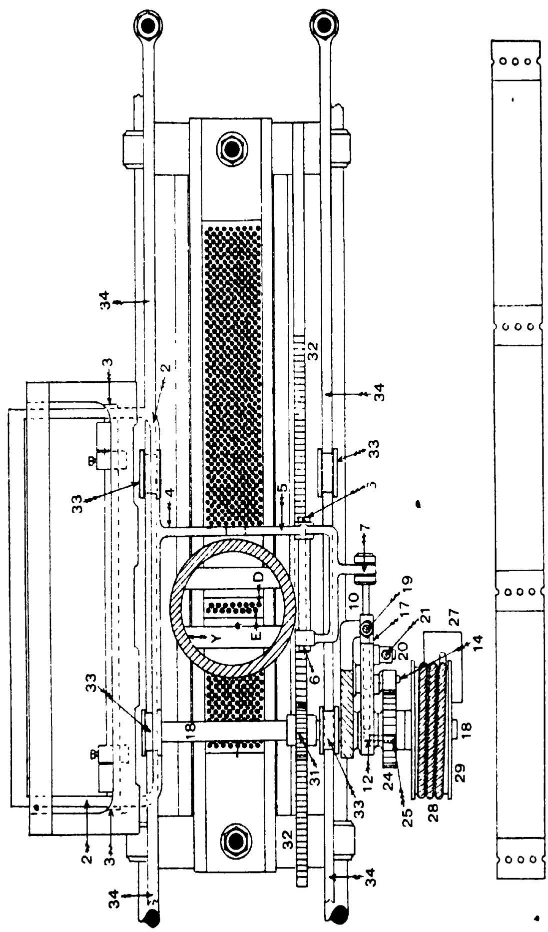


Fig 126.

the paper A. At the same time it will be evident that the pawl and hanging catch 15 will move upwards with the lever 17, and so place the point of the pawl opposite the next higher tooth in wheel 24, under which tooth it will pass when the operator withdraws the pressure from the key P; for immediately the fingers are removed from the keys, the spiral spring 26, Fig. 123, raises arm 7 and rod 8, and thus rotates the three-armed lever

counter-clockwise. The slot in the arm of 11 thus carries the pin 14 and the pawl of the hanging catch 15 to the left, and places the pawl in the next higher tooth to that with which it is at present engaged. The upward movement of arm 7 by spring 26 depresses the arm 5 and arm 4, and hence raises the arm 2 and all the keys P to their normal position.

Simultaneously with the insertion of pawl 15, Fig. 125, is the withdrawal of pawl 25 due to the slight rotation of the three-armed lever 10, 11, and 12, and since at this moment the pin 14 is near the upper end of the slot in the arm 11, in consequence of the raised position of lever 17, the latter and all its connections are pulled down by means of the heavy weight 27 and rope 28 acting on the rope pulley 29 on shaft 18. This slight rotation moves ratchet wheel 24 until the set-screw 19 in the end of lever 17 reaches the stop block 30. This action results in a downward movement of rod 21, and at the same time lifts the block X into its highest position ready for a similar action. The distance moved by the lever 17 can be regulated by the set-screw 19 and the lock-nuts near its end.

When the ratchet wheel 24 is thus turned one tooth, the main shaft 18 is partially rotated, and naturally through the same angle. Hence, wheel 31, Figs. 123 and 125, which is fixed to the shaft 18, also moves through the same angle. The teeth of wheel 31 work in a long rack 32, while grooved pulleys 33 run on rails 34; the wheel, rack, and pulleys thus enable the whole of the headstock to move a distance equal to two short rows, or 16 holes, every time the keys P are liberated by the fingers of the card-cutter.

The whole of the upper part of the cutting mechanism moves from left to right, and the cutting is repeated as described until the indicator—not shown in this machine—points to the position on the card where the central peg holes are situated in Fig. 125. At this place there is a blank tread, one short row in each set, or two short rows of punches F in all, being omitted in the plate H. When the headstock has passed over all the punches F, and the card is cut, it will be clear that there will be a considerable number of short punches F with their cutting points through the paper. These punches F must be withdrawn after the last pair of short rows has been cut. Two upright bars or rods, one only shown at 35 in Fig. 125, pass through suitable holes in the framework 36, and the upper ends of these rods are attached as shown to the two ends of the lifting channel H. By the aid of a foot lever the two rods 35 are raised, and hence the channel H lifts all short punches F clear of the card A. The card or paper is now rotated to expose a new position, the headstock brought back to the starting-point, and similar operations performed for the new card and all succeeding cards.

Figs. 127 and 128 are two views of one section of a card-cutting, lacing, and preparing department. In Fig. 127 there are two card-cutters working at two piano card-cutting machines, on the reading boards of which are

two designs; the design on the reading board of the far machine is a bordered design, while the other is probably a design for the field or repeating part of the filling. Two card-lacers are also at work—one lacing perforated cards which have probably been cut on one of the piano card-cutting machines on the left, while the other is lacing uncut or blank cards by means of a machine; both will be referred to later.

Three machines are shown on the right of Fig. 128; two of these, the outside ones, are of the fine-pitch type, but of a different make and on a

FIG. 127.

different principle from that shown in Figs. 123 to 126. The central machine in Fig. 128 is of the ordinary pitch type. Three designs have been placed on the reading boards merely to give the machines a workable appearance. The two largest designs are for full harness work, and are clearly intended for the fine-pitch machines, whereas the smaller design is for the ordinary jacquard, and is a common harness design. A roll or part of a roll of fine-pitch paper has been introduced into each of the fine-pitch machines illustrated in Fig. 128, while near the footstool of the far machine is a complete roll.

The line drawings, etc., which have been made to illustrate the mechanism and to aid in the description of the machine, embrace Figs. 129 to 147. In connection with the present machine it will probably be best to examine some of the details first, and then to show the complete views when a general idea of the chief parts is understood. The uncut roll of paper A, Fig. 129, is placed on the wooden roller B, and carried over the peg cylinders C and D; it is then brought down to the wooden roller E, and secured to it by means of a thin iron rod which fits into a corresponding groove in the roller.

FIG. 128

In the machine illustrated in Figs. 123 to 126 it was shown that the paper remained stationary until the cutting of the card was complete, when the paper was carried round to present the next blank portion, *i.e.* the equivalent of a card, in position. In the machine under notice we might mention that the card or paper itself moves sideways after each cut in a manner similar to that which takes place in the ordinary pitch piano machine. In addition to this sideways movement, the paper must be well under control so that it may be moved lengthways after each card or its equivalent has been cut. And it need hardly be pointed out that it is necessary to provide means for moving the paper backwards as well as

forwards; it is, as a matter of fact, desirable and essential that the paper may be turned in either direction at will for any number of cards. The mechanism for these movements lengthwise—*i.e.* the movement imparted to the paper by the cylinders—shall be described first.

On the end of the peg cylinders C and D, Figs. 130 and 131, seen clearly in the latter view, are two pairs of plain discs—F and G for cylinder C, and H and J for cylinder D. The two pairs of discs F and G are kept at the

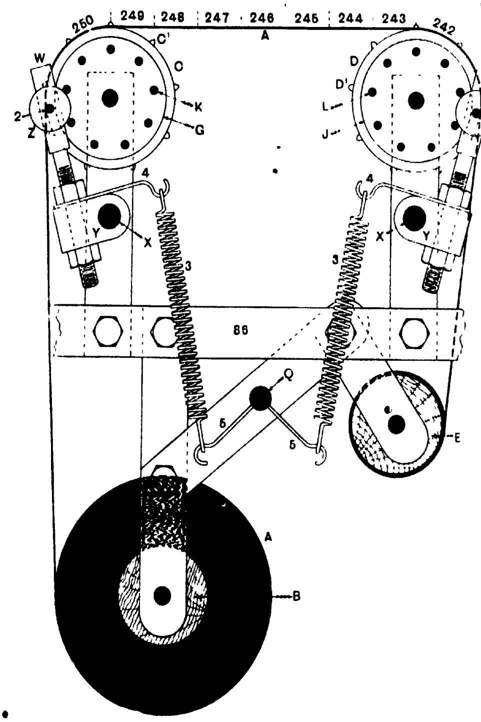


Fig. 129.

proper distance apart by nine pins K; and similarly the discs H and J are kept apart by the nine pins L. These pins serve two purposes, as by means of them the cylinders C and D are rotated, while after having been rotated through one-ninth of a revolution the pins provide means in conjunction with other parts for keeping the cylinders steady.

A double-hooked flat bar M, Fig. 130, is supported by a pin N which is held by the flat bars O. These two flat bars are riveted to a short arm of the L-shaped lever P fulcrumed on the stud Q. This short arm and the two bars O thus form a kind of fork. The long arm of lever P passes through a

slotted bracket R, and is provided with a suitable handle S. Two springs T and U are set-screwed to the bars O so that each spring may tend to keep its respective end of the hooked bar M in the highest position—*i.e.* in close

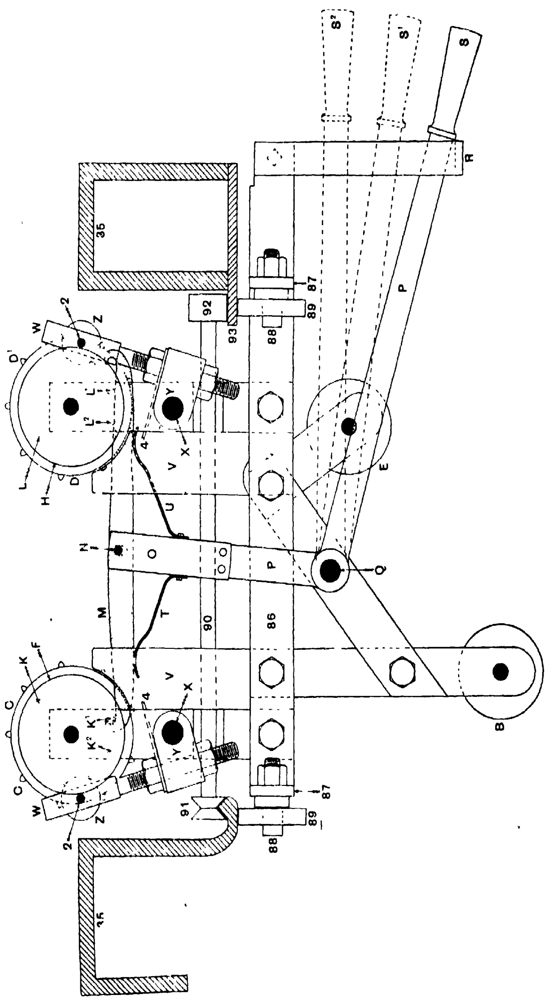


FIG. 130.

touch with the pins K or L, as the case may be. The necessary free movement of the hooked bar M is provided for by a slot in the centre of the bar which allows the latter to oscillate slightly on the pin N.

With the handle S in the lowest position, shown in solid in Fig. 130, it

is clear that the left-hand hook of the bar M will be in its extreme right position, and must therefore have pulled the pin K^1 so as to turn the cylinder C counter-clockwise through the distance of one card or pin. It will be observed that the right-hand hook of the bar M is quite clear of all the pins L. If the handle S be raised to the central position, shown at

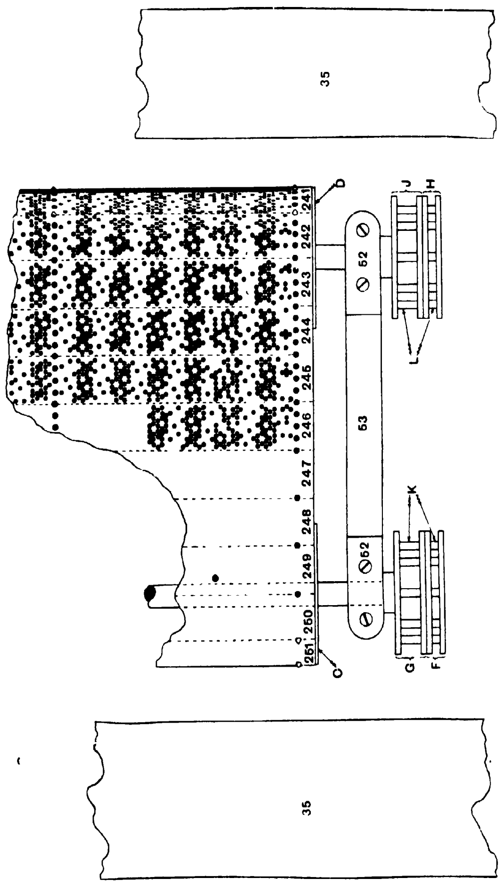


FIG. 131.

S^1 in dotted lines, the hooked bar M will be moved to the left; the right-hand hook will then have reached the next pin L^1, and the left-hand hook will have left the pin K^1 and will have slipped over the pin K^2, the spring T yielding to allow this. A further upward movement of the handle S from S^1 to S^2 will clearly cause the right-hand hook of bar M to pull the pin L^1 to the position at present occupied by the pin L^2, and hence will rotate the

cylinder D clockwise through the distance of one card, or one pin. This movement will also result in the left-hand hook of bar M being taken clear of the pin K^2—*i.e.* to a position corresponding to that occupied in the figure by the right-hand hook—and then this cylinder is free to rotate in the same direction as the other. The inoperative position of the handle S and all connecting parts is when the handle occupies the middle position S^1.

The two cylinders always move in unison, and thus carry the paper A, Fig. 129, forwards or backwards as desired, and of course for any number of successive cards in either direction. The hooked bar M, Fig. 130, slides between two pairs of supporting guides V so as to keep the hooked ends centrally situated between the discs F, Fig. 131, and the discs G respectively. Whichever way the cylinders C and D have turned, it is absolutely necessary that they should be forced into their proper positions, and then held there firmly during the whole time that the card is being cut. This essential condition is achieved by the action of the spring hammer W, fulcrumed at X, Fig. 130.

These parts will be more clearly seen in Fig. 129, where they are complete, and in which figure both discs F and H, Fig. 131, have been omitted, and so have the outer discs of G and J in order to show up the parts to advantage; the pins of G and H, however, are shown in Fig. 129. The spring hammer consists of the bolt W adjustable in the swinging bracket Y by means of the lock-nuts, and an anti-friction pulley Z fulcrumed at 2 in the bolt W. This apparatus is somewhat similar to and performs the same functions as the spring hammers in a jacquard machine—*i.e.* when the cylinder is rotating and has nearly reached its proper position, it is forced there by the pressure of the pulley Z through the action of spring 3 connected to hooks 4 and 5, the latter of which remains stationary.

The mechanism just described, which occupies the upper part of Fig. 130, is situated in a position approximately midway in the machine, but is capable of moving a distance equivalent to the length of the longest card which is used on the fine-pitch jacquard machines. The view of the mechanism in Fig. 130 is taken as looking towards the discs of the cylinders C and D, while the lower part of the same figure and Fig. 131 constitute one plan view of a part of both cylinders C and D and a number of cut and uncut cards bridging the gap between the two cylinders. We shall refer to Fig. 131 later.

We might now with advantage see how the piano keys operate the various rods and levers for the punches, and also see how the latter are operated in the headstock. The parts for this demonstration are illustrated in Figs. 132 to 136. Fig. 132 is a view of the headstock looking towards the discs of the cylinders C and D; the punches in the headstock are

arranged in two rows to cut holes in the card in the zigzag order as usual, and as illustrated in the small detached view at the bottom of the figure. There are two sets of punches, long ones 28 and short ones 27, enlarged views of which appear in Fig. 133; they are arranged as such simply for

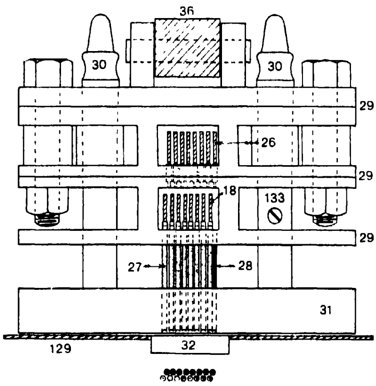


FIG. 132.

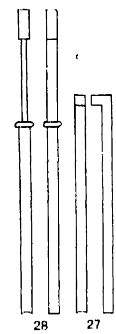


FIG. 133.

convenience, and the method of bringing each set into action is somewhat similar to that illustrated in Figs. 115 and 116.

Figs. 134 and 135 are side views of the headstock taken from the front of the machine; these figures also show the connections to one of the rods

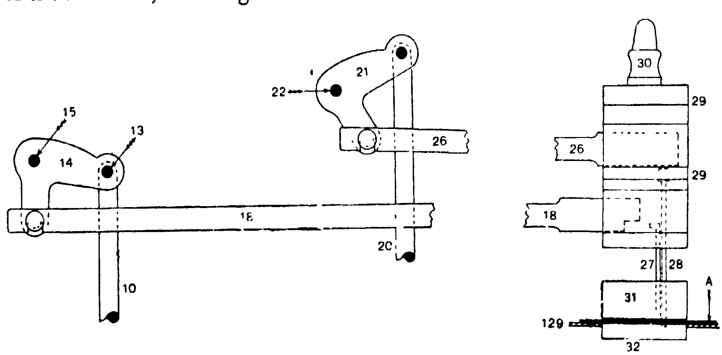


FIG. 134.

10, which is actuated directly from the piano-key lever 7, Fig. 136. Both rows of holes shown at the bottom of Fig. 132, or as many as are required in the two rows, are cut at the same time; hence 16 piano keys with their corresponding levers and other connections are essential. Two sets of connections are shown in Figs. 134 and 135, but one piano key only is shown at 6, Fig. 136, while its position when pressed down is represented by the

dotted part 6^1. The key is fixed to one end of the key lever 7, fulcrumed at 8. The back end of the lever 7 is weighted as indicated at 9, so that the parts have always a tendency to keep the key 6 in its highest position, and they do so when the operator's finger is lifted from the key.

The lower end of an upright rod 10 passes through a hole near the weighted part of lever 7, then through holes in the table and in the horizontal plate 11 supported by two pillars 12. At a point immediately above the plate 11 the rod 10 is bent almost at right angles, Fig. 136, and then attached at 13, Figs. 134 and 135, to the bell-crank lever 14 fulcrumed at 15. The bell-crank lever is supported by and free to turn slightly in the slotted or forked plate 16, Fig. 136, which depends from the plate support 17. The exact position of the rod 10 with regard to its influence on the long bars 18 (shown broken in Figs. 134 and 135) is regulated by means of the lock-nuts 19, Fig. 136.

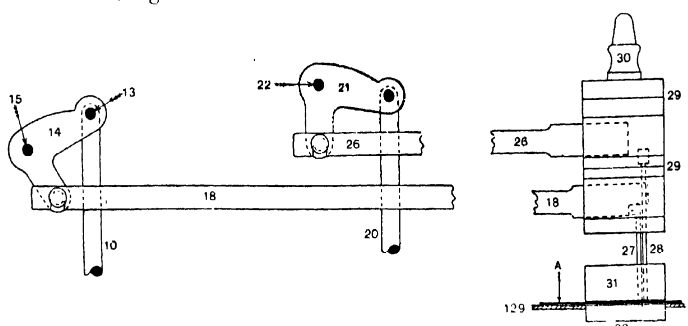


FIG. 135.

In the complete set there are 8 such rods 10, and these are operated by the first eight piano keys to the left of the machine. The next eight piano keys—*i.e.* Nos. 9 to 16—operate precisely similar levers to 7 ; but the rods 20, which correspond to and play the same part as rods 10, are bent at a bigger angle immediately above the plate 11, in order that they may be attached to the upper set of bell-crank levers 21, fulcrumed at 22. In Fig. 136 one of the rods 20 is also shown in its highest position at 20^1. The bell-crank levers 21 are also supported by forked plates 23 (see Fig. 137), which in turn depend from the horizontal plate support 24. The two plates 17 and 24 are supported by pillars 25. Attached to bell-crank levers 21, Figs. 134 and 135, are eight long bars 26 very similar to those marked 18, but occupying a higher plane. The horizontal plate supports 17 and 24, Fig. 136, are in reality joined, but they occupy different heights because the respective parts which they support have to operate the higher and lower sets of long bars 26 and 18, Figs. 134 and 135.

The free ends of bars 18 and 26 enter suitable recesses in the headstock (see Figs. 132, 134, and 135). Inside the upper recess is a grate which guides the free ends of the long bars 26 over their respective punches 28, Fig. 133, while the free ends of the lower long bars 18 are guided somewhat similarly over the tops of the short punches 27 in the lower recess, and pass between

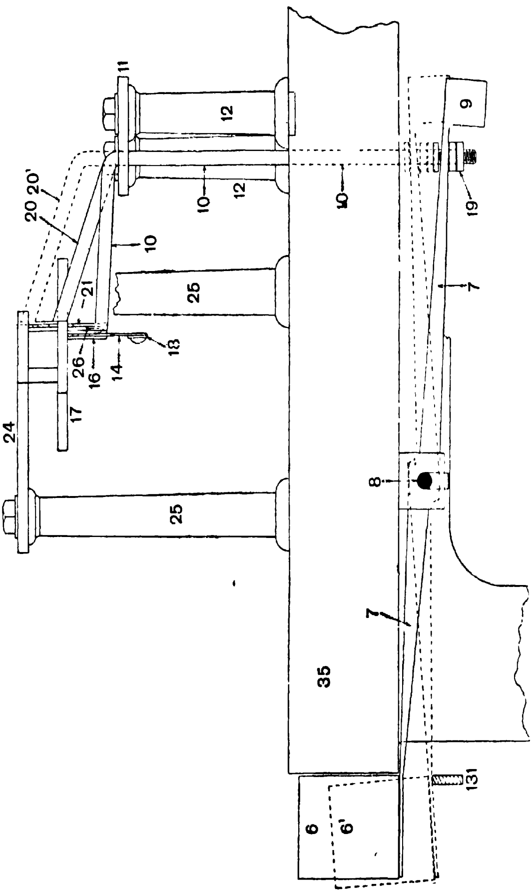


Fig. 136.

the thin parts of the long punches. The views of the long punches in Fig. 133 will show that this is possible. It will be evident that when the bell-crank levers 14 and 21, Figs. 134 and 135, are raised in virtue of the downward movement of the corresponding piano keys 6, Fig. 136, the long bars 18 and 26 will be carried forward—*i.e.* to the right in Figs. 134 and 135—and their extreme free ends will be placed respectively over the top of one

short punch 27 and one long punch 28. In Fig. 134 the lower long bar 18 is in its normal position—*i.e.* with the piano key up—whereas the upper long bar 26 has been moved about $\frac{9}{16}$ in. to the right by the bell-crank lever 21, because the corresponding piano key 6, Fig. 136, has been pressed down and the rod 20 raised. The end of the long bar 26, Fig. 134, is consequently over a long punch 28. In Fig. 135 the conditions are reversed—that is, the end of the lower long bar 18 is over the top of a short punch 27, while the upper long bar 26 is in its normal position.

In Fig. 134 it will be seen that the long punch 28 has been forced through the card or paper A, and the short punch has remained stationary on the paper while the plates 29 of the headstock have moved downwards to their lowest positions. Conversely, in Fig. 135 the short punch 27 has been forced through the paper, while the long punch 28 was unaffected. The plates 29 of the headstock move up and down on two pillar-rods 30 under the influence of the treadle and intermediate connections. Plate 31 is a guide plate or block, and the paper A is cut between this plate and the lower plate 32.

Fig. 137 is a front elevation of the complete machine; Fig. 138 is an end elevation looking from the left of Fig. 137; Fig. 139 is an elevation of the opposite end; Fig. 140 is a complete plan; while Fig. 141 is also a plan, but with certain parts removed to show details of the mechanism more clearly. In these views the keys are in solid black and stippled alternately, to facilitate the fingering; and in order to enable one to follow the connection, the rods 10 and 20 are similarly marked, although it must be remembered that the rods 10 and the first eight keys operate one row of punches, while the rods 20 and the other set of keys operate the other row of punches. The point-paper design, as already indicated, is pinned on the board 33 with the first thread of the design on the left, and the first pick at the bottom. In this particular machine the reading board is supported by brackets 34 fixed to any convenient part of the table or frame 35 (see also Fig. 128).

The downward movement of the plates 29, Figs. 138 and 139, of the headstock is due to the similar downward movement of the end of the short arm of lever 36, Figs. 137 and 141, fulcrumed on a pin 37, and between the two brackets 38; the latter are bolted to the top of the table 35. A pin or stud 39 connects the long arm of lever 36 with a small bracket 40 on the upper end of rod 41. The rod 41, Figs. 137 and 138, is attached to a forked bracket 42 near the end of the treadle 43, and the latter is fulcrumed on a pin 44 held by two brackets 45. From these connections and parts it is obvious that when the end of the treadle 43 is depressed, the plates 29 of the headstock will descend. The upward movement of the treadle and of the plates of the headstock is obtained by the action of the spring 46, Figs. 138 and 139. This spring encircles the rod 47, which is connected to the bracket

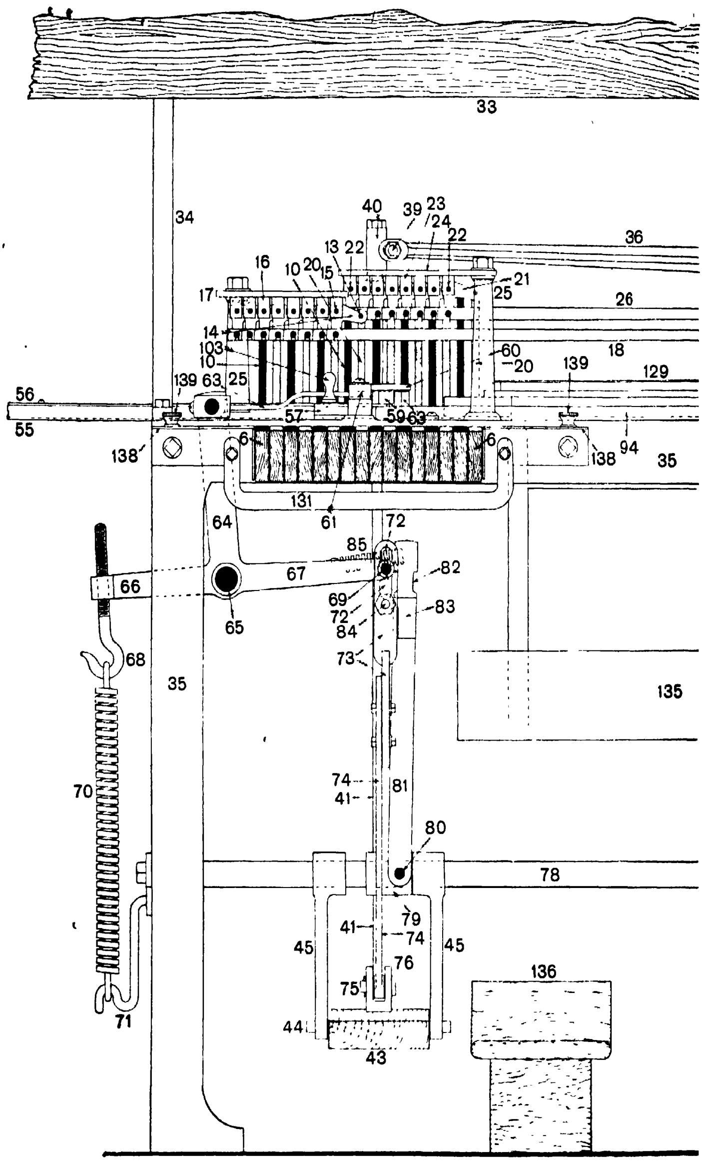


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Fig. 137.

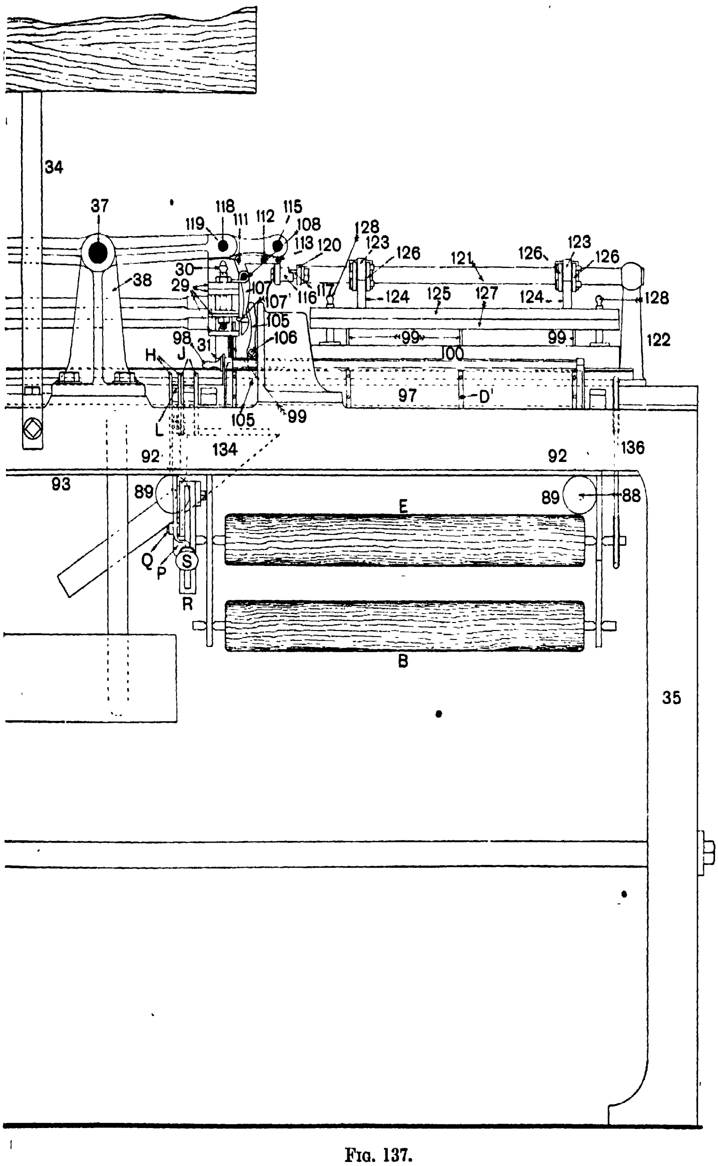
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Fig. 137.

48 on a stud 49; the latter projects from the rear end of the treadle 43.

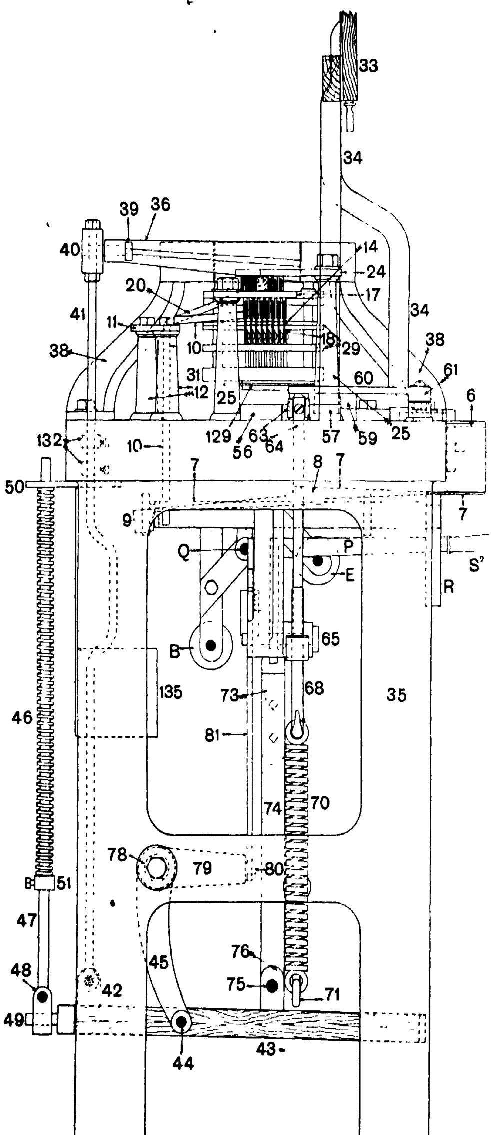


FIG. 138.

The upper end of rod 47 passes through a hole in the plate 50, which is bolted to the underside of the table, and thus acts as the upper check to the spring 46. A collar 51 can be adjusted on the rod 47 to enable the spring to possess the necessary force for returning the treadle 43 and plates 29 of the headstock safely to their highest positions.

It will be understood from what has been said that the necessary holes in two zig-zag rows of the paper are cut at each downward movement of the plates of the headstock, and that after such movement, and before the next downward movement takes place, the paper, together with the two cylinders C and D, Fig. 129, and all other essential connections, must be drawn forwards or to the left in Figs. 137, 140, and 141, a distance equal to the space occupied by two rows of holes.

Before the above action of drawing the cylinders, etc., to the left takes

place, it is necessary that the ends of all punches 27 and 28, Fig. 132, which for the moment are through the paper, should be raised clear of the paper, otherwise it is quite evident that the punches would tear the paper. The mechanism which is introduced to delay the movements of the above parts until the punches are safely withdrawn from the paper, works in conjunction with, and by the action of the treadle 43; it is illustrated in Fig. 131 and Figs. 137 to 141. The two cylinders C and D are supported in suitable bushes in the brackets 52, the two pairs of brackets being connected by cross-rails 53. One end of the rack 54, Fig. 141, is bent at right angles and bolted to the nearer cross-rail 53, or it may be connected to both cross-rails as illustrated. The rack 54 slides on the base of the rack guide case 55, which may be closed at the base, or part may be cut away just as desired. In either case, the cover 56 is screwed to the top of the case.

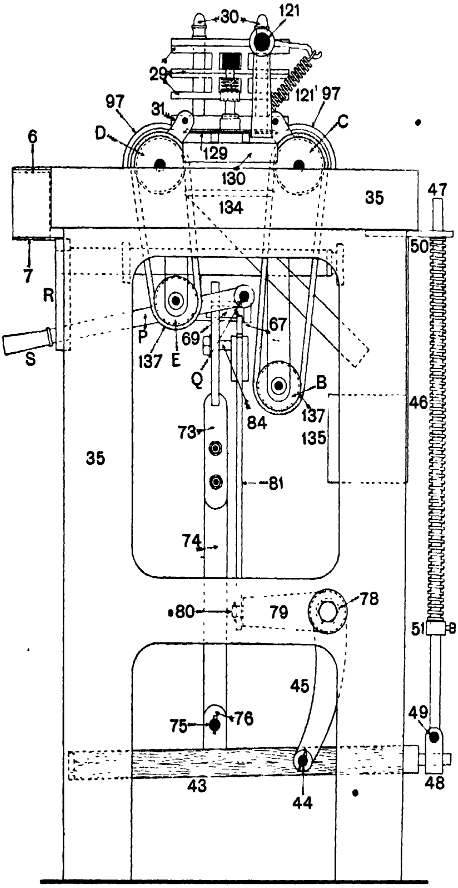


Fig. 139.

In Fig. 141 the cover of the case is omitted, and so is the cover of the pawl box 57, in order to illustrate more clearly the function of the mechanism. The pawl 58, which imparts motion to the rack 54, is fulcrumed at 59 near the middle of lever 60, which in turn is fulcrumed at 61. The other end of lever 60 is attached at 62 to the bar 63, and the opposite end of bar 63 is forked to receive the end of the vertical arm 64, Figs. 137 and 138, of a three-armed lever fulcrumed at 65. The two horizontal arms 66 and 67

are attached respectively to the screwed hook 68 and the stud 69. The

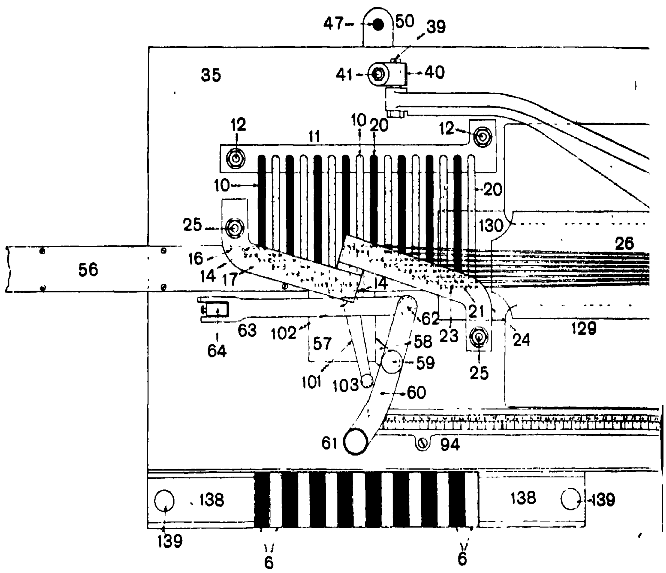


FIG. 140.

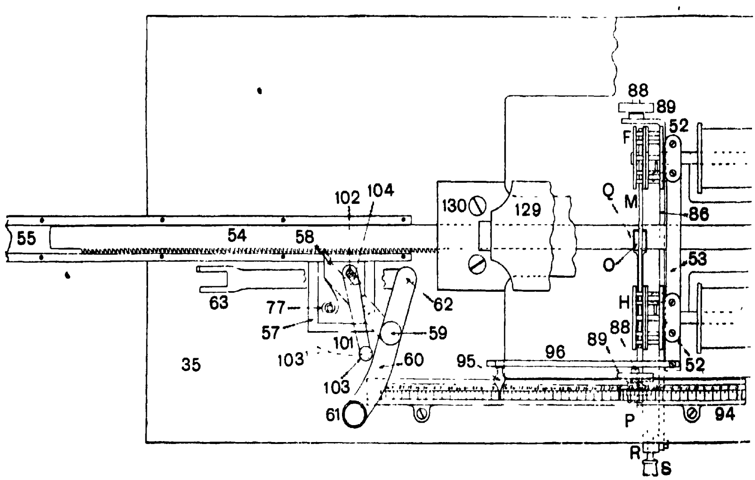


FIG. 141.

hook 68, and therefore the three-armed lever 64, 66, and 67, Fig. 137, are kept in the position shown by the action of spring 70, and the latter is

hooked as shown to 68 and to the bottom hook 71, which is bolted to the frame. The stud 69 projects from the side of the lever 67 and enters the

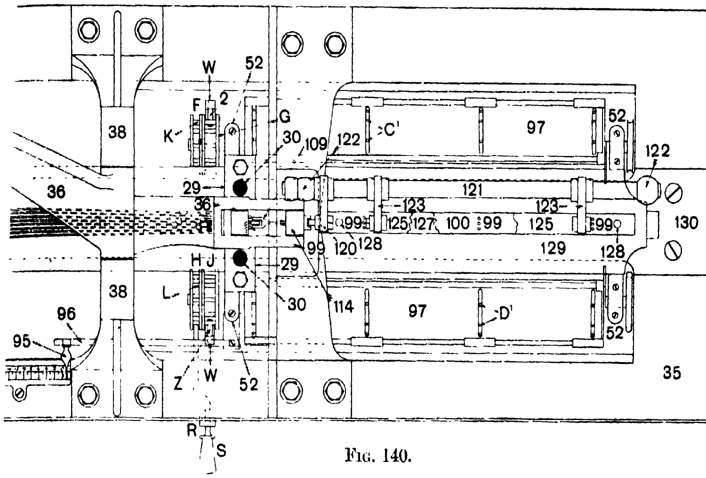


FIG. 140.

slot 72 in the bar 73. The latter is bolted to the bar 74, so that means of adjusting the combined length of the two are provided. The lower end of

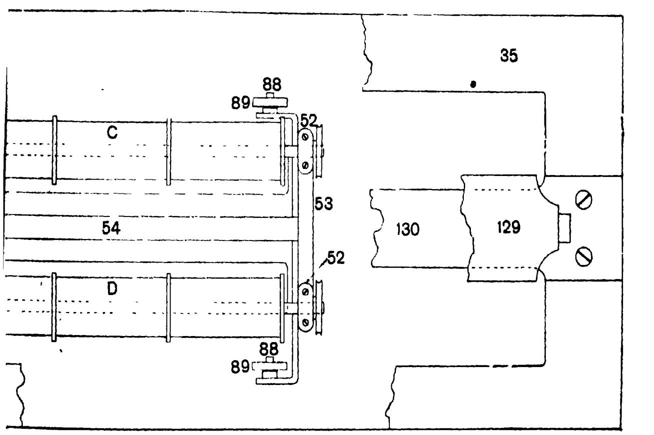


FIG. 141.

bar 74 is held by a pin 75 in a forked bracket 76, and the latter is securely fixed to the upper surface of the treadle 43.

After the operator has selected the proper keys 6, Figs. 137 and 140, according to the marks on the 16 vertical rows of the design-paper, she presses the keys down, and from what has been said it is clear that the free ends of the corresponding long bars 18 and 26 will cover their respective punches. She then depresses the treadle 43, which, in addition to causing the punches to pass through the paper, will evidently rotate slightly the three-armed lever 64, 66, and 67 clockwise. The upper end of the vertical arm 64 will thus cause the bar 63, Fig. 141, and through it the pawl 58, to move to the right, taking the pawl 58 from the position shown in Fig. 141 to the position occupied by the next tooth on the right. The pawl 58 is kept in touch with the teeth of the rack 54 by the scroll spring 77. It is quite evident that when the operator releases the pressure on the treadle 43, the spring 46, Figs. 138 and 139, will bring back the treadle to its highest position, and, as previously mentioned, will also cause the punches to be raised clear of the paper. It is equally evident that the three-armed lever, as well as the rack, would move at the same time unless special provision were made to prevent it. The arm 67, Fig. 137, of the three-armed lever must remain in its lowest position until the punches have been raised safely into the block 31. This requirement is obtained in the following manner: Projecting from the stay rod 78, upon which the brackets 45 are fixed, is a bracket 79. A stud 80 projects from the face of bracket 79, and upon this stud is placed the lower end of the flat bar 81. The upper end of this bar is recessed at 82 as shown, and at both sides, although one side only can act. A small plate 83 is riveted to bar 81. A stud 84 is fixed to the lever 73 near the bottom of the slot 72, and a spring 85 joins the upper end of bar 81 to the lever 67, the former being thus kept in close contact with the various parts. As the treadle 43 is descending, the top part of the slot 72 approaches and ultimately comes in contact with the stud 69 in the lever 67. The stud 69 therefore begins to move in unison with the bar 73 until it has descended sufficiently far to allow the recess 82 to slip over a corresponding part in the stud 69—the spring 85, of course, drawing the bar 81 with the recess into contact.

With the upward movement of the treadle 43 the bar 73 rises, but the stud 69, and therefore the three-armed lever, is unaffected until the stud 84 comes in contact with the curved part of 83. Any further upward movement of the stud 84 will force the bar 81 outwards through the projecting part on piece 83, and thus release the stud 69. Immediately the latter is free to move, the spring 70 pulls down the arm 66, and therefore moves the bar 63, Fig. 141, and the pawl 58 to the left. This will clearly enable the pawl to take the rack with it, together with the two cylinders, paper, and all connections, a distance of one tooth or two zigzag rows.

The cylinders C and D, Fig. 141, and all connected parts are capable

of being moved the full length of the cut portion of the longest cards, or rather widest paper; and in order to enable this movement to be conducted with accuracy and with as little friction as possible, eight anti-friction pulleys (six plain pulleys, and two V-grooved pulleys) are employed. The arrangement of the pulleys is best seen in Fig. 130, where the cylinders and all parts are shown connected directly or indirectly with the flat bar 86. At the correct distance apart on the flat bar 86, and at right angles to its face, are two projecting parts 87, which are provided with pins 88, upon which rotate two of the anti-friction pulleys 89. Parallel to the bar 86, and in a higher plane, is a small shaft 90 on one end of which is a V-grooved pulley 91, and on the other end an anti-friction pulley 92. The two pulleys on the right, 89 and 92, rotate against the lower and upper surfaces of a plate 93, which is bolted to the frame and projects as shown, while another pulley 89, on the opposite or left side in the illustration, rotates against the underside of a specially shaped part of the frame 35, the upper surface of this part being made in the form of an inverted V, and on which runs the V-grooved pulley 91. A similar set of four pulleys is arranged near the end of the cylinders C and D; the grooved pulleys 91 prevent any side movement on the part of the mechanism, and thus enable the cutting to be accurately spaced.

The number indicator 94, Figs. 140 and 141, is screwed to the top of the table 35; and as the cylinders move after each two rows have been cut, the pointer 95, which is attached to the cylinder support 53 by the narrow flat bar 96, moves in unison with the remaining parts, and indicates the rows which are under the punches 27 and 28.

The roll of paper is usually delivered with peg holes cut between each pair of cards as illustrated in Figs. 142, 143, and 144; such paper is made by French and German as well as British firms. The cards in Figs. 142 and 143 are reduced to two-fifths of the actual size, and are for 896's jacquards, while the card in Fig. 144, shown one-fourth the actual size, is for a 1344's jacquard. In all three cases the foundation of the strengthening strips is cloth. In Figs. 142 and 143 a scrim made from high-count cotton yarns in a low sett is used, and this is fixed on to the strengthening strip paper before it is attached to the proper paper—probably in wide widths and then cut up into strips of the proper width. In the strips of the card in Fig. 144 the foundation cloth is made from high-count cotton yarns in a comparatively fine sett, and then this cloth is heavily loaded, and finally embossed to represent a twill cloth. The advantage of the card in Fig. 143 is that the position of every needle in the jacquard machine or hole on the paper is printed on the paper, and hence this improvement facilitates the location of the position of any needle of the jacquard machine or square of the design-paper.

Before placing the paper over the cylinders C and D it is necessary to swing back the brass covers 97, Figs. 137 and 140, which, when in position, are concentric with the peripheries of the cylinders, and are held there securely by a long rod at the end of which is a small handle 98. The

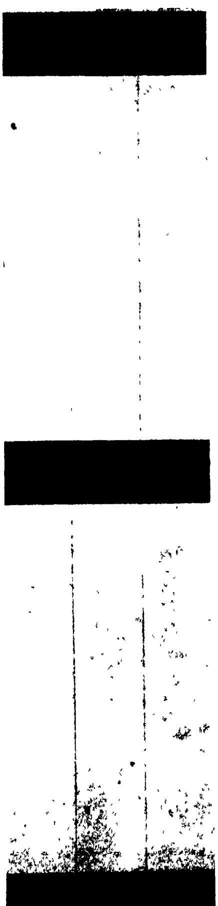


Fig. 142

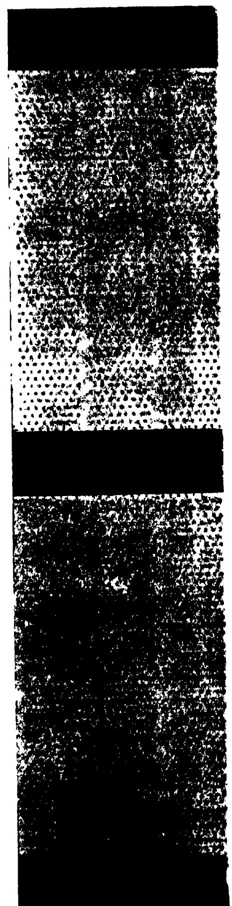


Fig. 143.

Fig. 144.

withdrawal of this handle about $\frac{1}{2}$ in. liberates the upper head of the cover from the side brackets, and since the covers are hinged at the lower edges they may then be easily turned outwards.

The pitch of the paper, or rather the width required for each card, and the pitch of the holes in the paper illustrated in Figs. 142, 143, and

144, are the same as the pitch of the pegs C^1 and D^1 on the circumferences of cylinders C and D, Fig. 130. When the design is cut on the card as illustrated in Fig. 122, there are three additional peg holes on each strengthening strip for each card. These extra holes are for use on the jacquard machine if from any cause the normal ones, or those shown in Figs. 142, 143, and 144, become damaged, and these extra holes are cut in the piano card-cutting machine. For a 1344's jacquard machine there are four strengthening strips on the paper, see Fig. 144; consequently the piano machine must be provided with four sets of peg punches, three punches in each set. These are shown at 99, Figs. 137 and 140. Three of the sets are in the peg-hole punching block 100, while the remaining set is in the headstock and immediately to the right of the two rows of ordinary punches 27 and 28.

In order to make the description of the operation of cutting as simple and intelligible as possible, we shall imagine that the last row of one card has been cut, and that therefore the cylinders C and D, Figs. 137, 140, and 141, and all connected parts, will be at the extreme left position, with the index pointer 95 over the last mark on the scale. This done, it is now necessary to move the cylinders, paper, etc., to the other extreme end, or starting point, but before this can be done the pawl 58, Fig. 141, must be withdrawn from contact with the rack 54. A lever 101, fulcrumed at 102, is provided with a small handle 103. A small cam 104, integral with the lever 101, is also on fulcrum 102; and when the handle 103 is moved to the position indicated by 103^1, the cam 104 will have forced out pawl 58 quite clear of the teeth of the rack 54.

The position occupied by the cam 104, when the handle 103 is rotated to the point marked 103^1, is such that the pawl 58 cannot be forced in by the scroll spring 77, since the force of the latter against the cam is directed through the fulcrum 102.

The treadle 43, Figs. 137, 138, and 139, is kept down when the last row in the card or paper has been punched; then the operator turns the small handle 103, Fig. 141, as described, to release the pawl, lifts up the handle S, Fig. 130, from the central position S^1 to the top position S^2, which rotates the cylinders C and D towards the operator, or in what we have termed the forward direction, and brings the next blank card into position; finally she pushes the handle S to the right in order to place all parts at the other extreme end ready for the cutting of the next card.

There is a small projection fixed to a convenient part of the back cylinder D, and just before the cylinders reach the starting point on the extreme right this projecting part reaches and touches the lower arm of the lever 105, fulcrumed at 106, Fig. 137. It is therefore evident that the last slight movement of the cylinders towards the right will cause

the projecting part to force the lower arm of the lever 105 to the right, and the upper arm of the same lever to the left. Simultaneously the lower arm of lever 107, fulcrumed at 108, will be forced to the left and its upper arm to the right.

A view of this section of the mechanism on a much larger scale is seen in Fig. 145, in which the ordinary long and short punches 28 and 27, one of each, as well as one of the three peg punches 99, are shown in the headstock. In this view the cylinders are supposed to have reached their extreme positions, and the above-mentioned levers 105 and 107 have been moved from the positions indicated in Fig. 137, so that the overhanging part of the lever 107 has been forced over the top of the three peg punches 99 (only one shown) in the headstock. And at the same moment the upper arm of lever 107 will have forced the links 109 and 110 to the right. Pins 111 and 112 join the parts 107, 109, and 110. The latter, through pin 113, will have caused the pendent arm 114, which is loose upon the pin 115, to move to the right, and hence to carry the short tube 116 towards the pin 117 in such a way that the end of the latter will enter the tube as shown. The two detached views immediately under these parts in Fig. 145 show sectional views of the tube, part of the upper portion of which is cut away, with the pin 117 in the tube in one view, and out of it in the other.

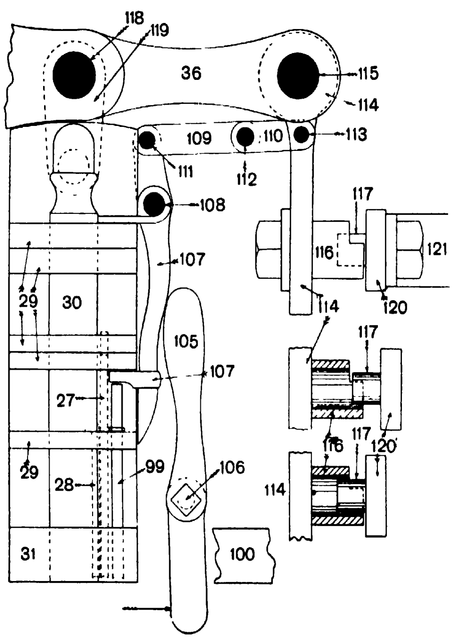


FIG. 145.

With the parts in the positions indicated in Fig. 145 it is quite evident that when the treadle 43, Fig. 137, is depressed, and the end of lever 36 caused to move downwards, the headstock will be forced down by means of the pin 118 and the link 119, Fig. 145, and at the same time the three peg punches 99 in the headstock will be forced through the paper by the projecting part of the lever 107. It is also evident that since the pin 117

is inside the tube 116, the upper part of the tube will carry the pin downwards, as well as the lever 120 to which the pin is bolted.

Referring now to Figs. 137 and 140, it will be seen that the lever 120 is fulcrumed on a long rod 121 supported by pillars 122. Two similar levers 123 are fixed to the same rod 121, and these are connected to the upright rods 124, Fig. 137, rising from the upper block 125, by means of links 126. Consequently, when the lever 120 is carried down by the action of the tube 116 on the pin 117, it is evident that the rod 121 will be partially rotated, and sufficiently far to enable the connections to impart a downward movement to the blocks 125 and 127; these move vertically on the slides 128, and thus force the remaining three sets of punches, nine punches in all, through the strengthening strips of the paper for that particular card.

We hardly need mention the fact that the parts 120 to 128 are operated once only for each card, and that immediately the foot pressure is removed from the treadle 43 the cylinders are moved by the pawl 58 and the rack 54, Fig. 141, the small projecting part on the back cylinder being withdrawn from the lower arm of lever 105, Fig. 145. When this happens a small spring causes the lower arm of lever 107 to withdraw the projecting part from the peg punch 99 in the headstock, and, of course, simultaneously to break the contact between the tube 116 and the pin 117, while a spiral spring 121^1, Fig. 139, brings rod 121 to its normal position. During the operation of punching for the remainder of the card, the tube 116, Figs. 137 and 145, can descend each time with the headstock without affecting the pin 117 and connected parts, as will be clearly seen in the right-hand detached illustration near the bottom of Fig. 145.

The first move of the cylinders to the left carries the pointer 95, Fig. 140, from the double mark on the scale to No. 0. The peg holes which have just been cut by the peg punches in the headstock will now be under the two rows of ordinary punches in the headstock; hence, with the pointer at No. 0 there must be a blank tread, after which the pointer 95 moves to No. 1 (even numbers only are marked on the scale). There are then 28 treads in regular succession representing $28 \times 16 = 448$ positions on the paper for 448 needles in the jacquard machine. Then another double line appears on the scale, and this represents another blank tread, because the middle of the second strengthening strip is then under the two rows of ordinary punches in the headstock.

The second division—*i.e.* from No. 29 to No. 56 on the scale—represents the next 448 positions or needles, and these are cut similarly to the first section. If the jacquard machine to be used contains 896 needles—that is, for a card similar in size to those in Figs. 142 and 143—the cutting is finished when the pointer 95 reaches No. 56 on the scale, Fig. 140,

and the cylinders are returned to the starting point as already described. If, however, the card is similar to that in Fig. 144, and for a 1344's jacquard, the operation is continued, starting with a final blank tread at the position indicated by the pointer 95 in Fig. 141, which shows that all parts have moved to the left for this distance. For such a card the cutting would finish at No. 84 on the scale—that is, 84 × 16 = 1344 needles. As the paper is moving from one end to the other it is supported by a long wide brass plate 129, Fig. 140, and the latter is in turn supported by the bridge 130.

In order that the correct travel may be imparted to the various levers from the keys 6 to the headstock, the levers are checked in their downward movement by the bar 131 bolted to the frame 35, Figs. 136 and 137. Provision is also made to limit the movement of the treadle 43 and the headstock by the collars 132, Fig. 138, on the rod 41, while a further check is introduced in the headstock as shown by the screw 133, Fig. 132.

All the cuttings from the under-block 32, Fig. 132, of the headstock fall into the funnel 134, Fig. 137, and ultimately into the box 135. A footstool 136 is usually placed as shown. Circular leather driving belts 137 are provided to help to draw forward the paper, and in general to keep it at the proper tension without undue stress.

It is sometimes desired to use fewer needles, say 12 rows instead of 16. When this is the case it is very desirable to cover up those keys which are to remain idle, and the rows to be cast out are the two outside rows on each side of the card—that is, the outer ones in each of the two zigzag rows. Thus, the following numbers in Fig. 146 represent one pair of rows, or 16, and those numbers crossed out represent the rows not in use:

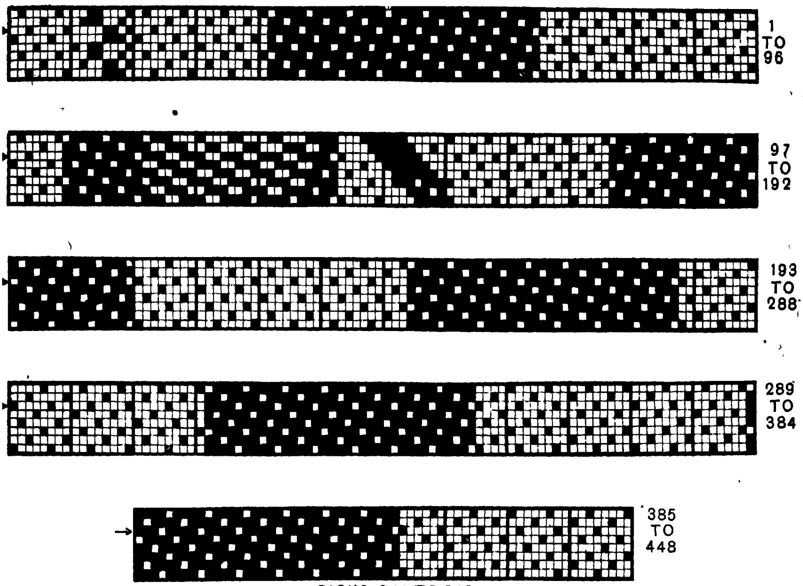
~~9~~ 10 11 12 13 14 15 ~~16~~
~~1~~ 2 3 4 5 6 7 ~~8~~

FIG. 146.

The 1st and 16th keys are covered by sliding the plates 138, Figs. 137 and 140, over them, and then fastening the plates in position by the milled head screws 139. Another plate secured near to or on the fulcrum 61 in the same figures can be rotated until it covers the 8th and 9th keys. A larger number of keys at the ends can be covered by the plates 138 if fewer rows have to be in use.

In Fig. 129 the seven cards on the cylinders, or rather between them, are marked 243 to 249 inclusive. These are supposed to be the corresponding picks in a design, and it is quite clear that the 246th card is in a position immediately under the punches and in the course of being cut. The picks 241 to 246 are represented on the first six lines of the design in each group in Fig. 147, the pick marked with an arrow being the 246th,

which is only partially cut in Figs. 130 and 131. It will be noticed that there are 448 threads represented on the design-paper, in Fig. 147, and these represent all those in the first section of the card. It will also be



PICKS 241 TO 248

Fig. 147.

noticed that when one reads each pick from end to end, the corresponding marks on the threads will appear on the cards as below, starting at *,

25	26	27	28	29	30	31	32
17	18	19	20	21	22	23	24
9	10	11	12	13	14	15	16
*1	2	3	4	5	6	7	8

and so on, reading upwards on the card.

It has already been pointed out that neither lacing nor lace holes are required, as the total number of cards required is in one length of paper.

CHAPTER IX

READING-BOARDS; CARD-CUTTING MACHINE FOR THE LACE TRADE

In practically all piano and similar card-cutting machines the reading-board is supported by some convenient part of the framework of the machine, somewhat as illustrated in Figs. 67, 68, 69, 127, 128, 137, and 138. When cutting from two large sheets at the same time—say, when the design is intended for a 1200's jacquard machine of a fine or medium pitch type—it is obviously impossible to have the 150 blocks or bars of eight threads, or the 100 blocks of twelve threads, in one straight line, unless the blocks are exceedingly small. Even if the blocks were reduced to a convenient size for the purpose of having them on the same line, the designing and the reading would be conducted under very trying conditions, and hence the arrangement would be scarcely practicable. Therefore, when cutting from designs which are too wide to be read conveniently, the design-paper is in two portions, and each card is cut from the corresponding lines of the two pieces of point-paper, and consequently there are two straight edges, one in the lower part of the board and one in the upper part.

The process of cutting from two such designs is, even under the best arrangement, rather complicated and difficult, particularly if the operation sets up a pronounced vibration in the board. The usual method of supporting the reading-board is, on the whole, a suitable and convenient method, and is perhaps as good an arrangement as can be adopted when the machines have to be moved from place to place. When, however, a permanent position has been chosen and fixed for any particular machine, it would probably be an advantage to support the reading-board independently of the machine. This would not only give the card-cutter more freedom in performing the various operations, but would also eliminate the vibration which always obtains when the cutting is in progress; at the same time the permanent steadiness of the board would enable the operative to read more easily and more quickly, and the marks on the design-paper would not affect the eyes as much as they do when vibration

is present. With an independent support for the reading-board the eyes would be less fatigued, and greater production should result. These statements refer only to those machines where the reading and punching are proceeding simultaneously, or nearly so; for the plate machines, such as that illustrated at Figs. 88, 90, and 91, the arrangement illustrated is probably the best.

In all cases, however, one straight-edge at least is required. There are different methods employed for the movement or the use of the straight-edge. That illustrated on the reading-board in the above-mentioned Figs. 68 and 69 is moved positively in both directions, each side having

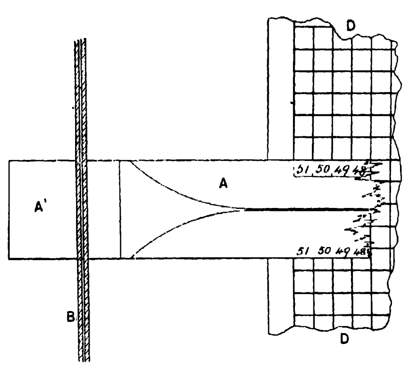


FIG. 148.

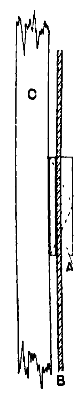


FIG. 149.

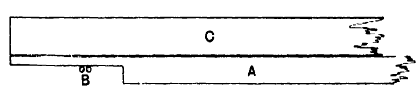


FIG. 150.

its separate adjustment. There is probably less chance of the straight-edge getting out of line with this type than with any other. The only objection to its use is the slowness of the movement when the cutter has to return it each time it reaches its limit on the board. For this reason some cutters dispense altogether with the screw adjustment, and fit up a simple and inexpensive arrangement such as that illustrated in Figs. 148 to 150, which show respectively portion of the front elevation, portion of the side elevation, and plan.

The straight-edge A is bevelled as usual, and is indicated by the dotted lines in Fig. 149. Each end A^1 is cut away as shown in Fig. 150, and two cords B are passed in front of the cut-away part; the upper ends of the

cords are passed over the top of the reading-board C, and the lower ends under the table, and then the ends are tied firmly together. The cords B thus hold the straight-edge A securely against the reading-board C, upon which the design-paper D is pinned as usual. The straight-edge can be moved easily and quickly after each line has been cut, and it is quite clear that when it is required to move it from its lowest position to its highest position it is only necessary to push it upwards—an operation which is done almost as quickly as the movement from one line to another.

Some cutters, and perhaps most of them, read from the upper edge of the straight-edge A, Fig. 148, where the last four large blocks of the design-paper are represented by the numbers 48, 49, 50, and 51; other cutters, on the other hand, read from the lines of the design-paper under the lower edge of the reading-board. The reading-board is numbered here also with the last four blocks. In the latter method the cutter can see the parts of the design which are to be cut next, but in the former case it is evident that the immediate uncut continuation of the design is under the straight-edge. When a standard size of design-paper is used, the straight-edge A is often painted white, ruled to the same pitch as the design-paper, and numbered in pencil for the guidance of the cutter.

A broad metal straight-edge is often used for a guide, and this metal edge, which is a fixture, is kept close in touch with the design-paper and the reading-board by means of two flat springs—one near each end. The card-cutter then moves the design-paper after each line has been cut, instead of moving the straight-edge. In this case the paper is not pinned to the board. The reading is thus always on the same line, and this line may be chosen at the most convenient height to suit the cutter. So long as the broad metal edge or plate grips the paper securely there is little danger of going wrong, provided also that the paper is moved carefully after each line has been cut, and the design-paper marked or checked on every cut line.

The production in regard to different pitches of cards and from different kinds of card-cutting machines for one or two particular kinds of designs has already been mentioned. It will be understood, however, that the speed of cutting is regulated not only by the skill of the operator, but also by the intricacy of the design; in other words, the speed of cutting is regulated by the speed with which the various blocks of the design can be read. It has been shown that the selection of the keys by the fingers and thumbs of both hands naturally follows the reading of the squares of the design by the eyes, and, subsequently, the feet complete the cycle of operations for each short row (or double row in some cases) on the card. Three distinct operations are thus involved in this very important process. However quickly the feet may be moved, it is obvious that the two previous

selections must be accurately made before the actual cutting takes place, and consequently the cutting speed is regulated in the first place by the quickness of reading, and in the second place by the rapidity with which the proper keys for each line can be selected. Hence it is only in connection with the simplest types of design that the reading and fingering can approach the maximum speed of tramping. This limitation probably accounts for the fact that, comparatively speaking, very few power cutting machines are in use in this country for the ordinary textile trade. A power machine, used in America, is illustrated in Fig. 119.

In the lace trade, however, the reading is by means of numbers, and for this particular class of design the power cutting machine has been used with some degree of success—indeed, it is said to be giving every satisfaction. But even in this case there will evidently be some difficulty in reading the numbers on the design, and selecting the proper keys in the headstock, with the same constancy as that which obtains in regard to the regular rising and falling of the punch box. As a matter of fact, although the machines may be driven by power, the essential relation between the punch box and the card carriage should be capable of being controlled in some way or other by the operator.

The parts necessary for the successful use of power in connection with card-cutting appear to be embodied in the power-operated card-cutting machine introduced about the year 1915 by Messrs. W. Martin & Son, Jacquard Works, Nottingham. Although this machine was invented with the sole object of being used in the lace trade, we see no reason why, with simple modifications, it should not be used for designs such as those for common-harness damasks, certain quilts, tapestries, double plains, and similar cloths, where the designs are for the most part in solid masses of colour and in unpainted and weaveless areas.

A general view of the front of the above power-cutting machine with the headstock and the reading-board appears in Fig. 151. An ordinary design appears on the reading-board, but, as already stated, the actual working design appears in numbers. In the first place, it should be mentioned that this machine and others for the lace trade differ from all ordinary card-cutting machines in that two cards are introduced side by side, and are cut simultaneously; the guides for the two cards are seen clearly at the foot of the headstock in Fig. 151 and in Fig. 153. Our remarks concerning the use of a machine similar to this for the ordinary textile trade imply, naturally, the changes which would be necessary to arrange for the cutting of only one card at a time of the desired pitch, but otherwise the present parts appear quite satisfactory, necessary, and sufficient.

The arrangements for driving the machine by power are illustrated in

Figs. 152 and 153. The short shaft A, Fig. 152, and the cone pulley B are operated as usual by the fast and loose pulleys C. A short belt, not shown, passes partially round the cone pulley B and a similar cone pulley D on the shaft E. This belt is under the control of a belt-fork, which is moved laterally by means of the left treadle F, Figs. 151 to 153, and a cord G. The cord G passes over two grooved pulleys, as shown in Figs. 151 and 153, and is then attached to the rod H, Fig. 152, and the latter in turn is fixed to the belt-fork. It will thus be seen that, although a constant speed is imparted to the shaft A, the speed of the shaft E may be regulated by the movement of the left treadle F and the consequent movement of the belt on the cone pulleys B and D. The normal position of the belt is for the slow speed, but for very simple designs the speed may be increased by depressing the left treadle, and the mechanism can be humoured to requirements.

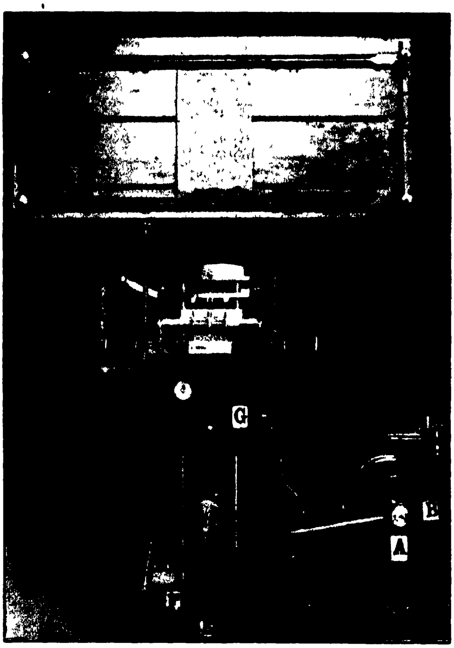


Fig. 151.

On the end of the shaft E, and near the front of the machine, Figs. 151 and 153, is fixed an eccentric J, which is attached as shown to the lower crosshead K. The latter is adjustably fixed by nuts L (see Fig. 154) to the two bars M, the lower ends of which are guided as shown by bracket N, while their upper ends are fixed to the upper crosshead O, Figs. 153 and 154. As the eccentric J rotates, the crosshead O receives the usual up-and-down motion. This eccentric obviously takes the place of the ordinary treadles, and it has already been pointed out that the downward movement of the left treadle in the foot-power machine causes the upper crosshead or headstock to rise, and at the same time causes the carriage and the card to move backwards one division. It is evident that even with the most skilful operative it would be a great disadvantage if the

carriage in the power-driven machine moved, without exception, one division backwards for every revolution of the eccentric. One of the chief features of the machine under notice is that, although the eccentric and the headstock move uniformly, the movement of the carriage is absolutely under the control of the operative, taking place only when and if one or more keys of the headstock are pressed in; in fact, if, for any reason, the selection of the proper keys cannot be accomplished by the time that the eccentric begins to draw down the headstock O, and if no keys happen to be pushed in, the downward movement of the headstock has no effect upon the carriage.

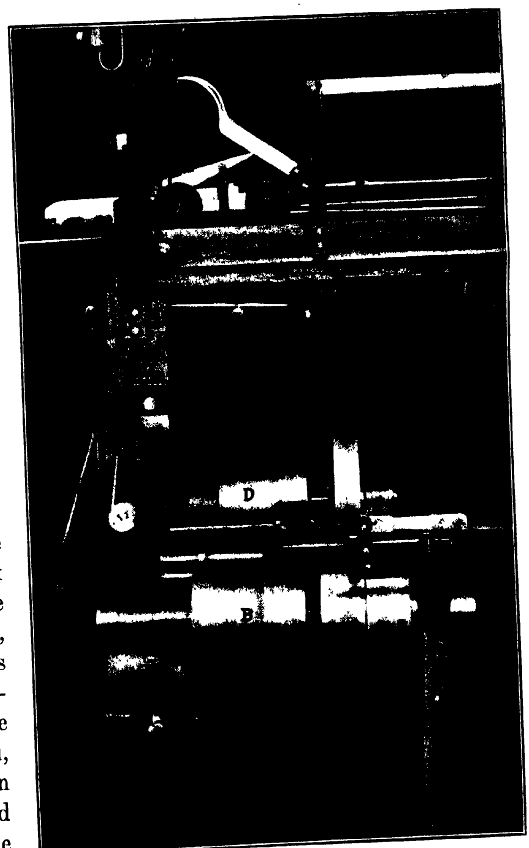


FIG. 152.

The bars M are attached in a suitable way to the headstock O, upon which is the usual wooden cap P, Fig. 154. This view is a longitudinal elevation of the machine and carriage, and, taken in conjunction with Figs. 155 and 156, will explain the chief parts of the mechanism. Two studs or pins Q, one at each end of O, pass through holes in the withdrawal plate R. The plate R can slide easily down and up on the two bars M, and its upper surface supports all the ordinary punches S and the large dummy punch or spacing punch T. Between the upper punch plate U and the withdrawal plate R are two spiral springs V which encircle the bars M, and serve to raise the withdrawal plate R to its

highest and normal position after it has been depressed by any of the punches S or T.

Secured to the withdrawal plate R are two plates W and W^1, Fig. 156, and these plates are provided with pins X and X^1. A connecting-rod Y joins the pin X to the short arm of lever Z fulcrumed at 2; while in a similar manner the connecting-rod Y^1 joins pin X^1 to a short lever Z^1, also fulcrumed at 2. The long arm of lever Z is attached at 3 to a connecting-rod 4, and the latter is attached to a link 5, which in turn is jointed to the lower arm of the bell-crank lever 6 fulcrumed at 7. Finally, a connecting link 8 joins the upper arm of the bell-crank lever 6 to a short arm 9 which forms part of a rocking-shaft 10. This shaft 10 extends nearly the full length of the machine, as shown in Fig. 154, and its upper surface is provided with a web 11, as indicated in Figs. 154, 155, and 156.

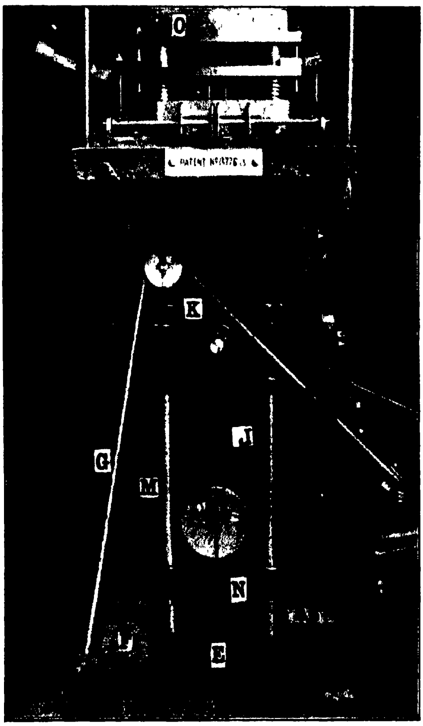


FIG. 153.

The two prongs of a forked bracket 12 fulcrumed at 13, Fig. 155, drop over the web 11, and hence the bracket 12 is under the influence of the web 11. Projecting from the same stud on fulcrum 13 is a short arm 14, and the end of this arm enters a suitable slot in a rectangular sliding plate 15, Figs. 154 and 155. This sliding plate 15 is provided with two oblique slots 16 and 16^1; two small pins 17 and 17^1 fixed to the catches or dogs 18 and 18^1 project into these oblique slots 16 and 16^1 of the sliding plate 15. The bottom ends of the catches 18 and 18^1 act upon the teeth of the rack 19, and thus control the movement of the carriage. In Fig. 154 the catch 18^1 is in contact with the teeth of the rack 19, while the catch 18 is quite clear.

The card 20 and the second card immediately alongside of it are between

the punch plates U and U^1, and are gripped in the usual manner by the rat-trap 21 on the short arm of lever 22 fulcrumed at 23; the necessary pressure to the lever 22 is imparted by the volute spring 24. The rat-trap is released in the well-known manner by the downward movement of lever 25 fulcrumed at 26. The carriage itself is supported by four wheels 27, while a similar number but smaller set of wheels 28 are attached to the pendent brackets 29; these two sets of wheels run on the upper and lower planed surfaces of the frame 30, and thus provide an easy and smooth movement for the carriage.

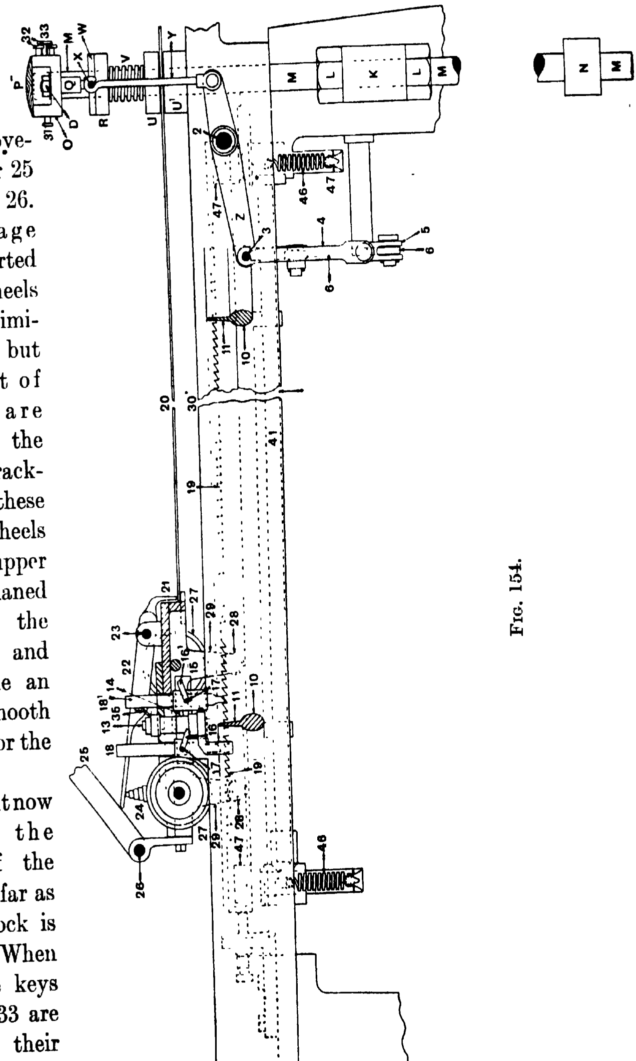


FIG. 154.

We might now consider the working of the machine so far as the headstock is concerned. When any of the keys 31, 32, or 33 are pushed in, their ends pass over the tops of their respective punches S, and when the headstock descends the shoulders of the punches force down the withdrawal plate R. The downward movement of the plate R naturally oscillates lever Z, Fig. 154,

about its fulcrum 2, and the further connections from the long arm of lever Z cause the bell-crank lever 6 to rotate slightly counter-clockwise, Figs. 155 and 156, and thus impart a clockwise movement to the rod 10 and its web 11. The stud 34, Fig. 155, is introduced to enable the proper degree of backward movement to be allowed to bell-crank lever 6.

The web 11 thus moves the forked lever 12 as well as the short arm 14, and the end of the latter causes the sliding rectangular plate 15, Fig. 154, to move to the left. In doing so, it is clear that the oblique slot 16^1 will cause the pin 17^1 to withdraw the catch 18^1 from the teeth of the rack 19, but at the same time the oblique slot 16 will cause the pin 17 to force the catch 18 into contact with the teeth of rack 19. The point of the descend-

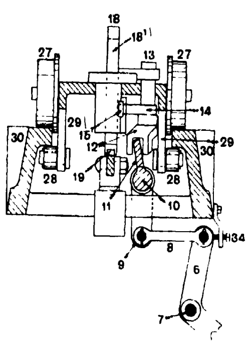


FIG. 155.

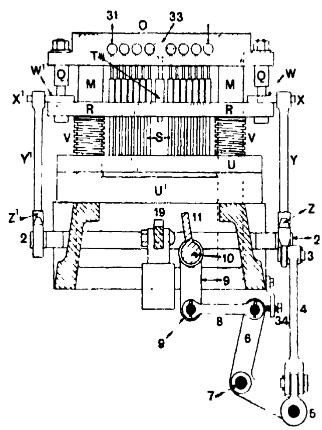


FIG. 156.

ing catch 18 reaches the tooth of the rack just before the catch 18^1 leaves the straight part of its tooth. This is necessary, for the carriage must remain stationary until the punching of that particular row is complete, and, indeed, until the punches are withdrawn from the cut portion of the card.

When the headstock O is rising, the springs V force the withdrawal plate R to its highest position, and thus bring back the web 12 and the sliding rectangular plate 15 to their normal positions—those shown in Fig. 154. While this is taking place, the catch 18 is naturally rising and the catch 18^1 falling. It is clear, however, that the catch 18^1 must not take the same tooth with which it was in contact the last time it was down. When the catch 18^1 is rising, it receives a slight clockwise movement in virtue of the pressure of the flat spring 35, and thus the lower end of the catch is moved to the left, and in descending the point of the catch comes

in contact with the sloping part of the next tooth—*i.e.* the one on the left of that with which the catch is at present in contact. The weight at the end of the cord is then free to draw the carriage backwards until the catch 18^1 assumes the vertical position, and these actions take place, one row at a time, so long as one or more punches is or are covered by their respective keys. If, however, no key is pressed in, it is evident that no movement will be imparted to the withdrawal plate R, and hence the thin parts of the studs Q, Fig. 156, of the headstock or crosshead O will simply slide down and up the holes in the withdrawal plate R. It is this unique arrangement of connections between the punches and the carriage which overcomes the practical difficulties which obtain in certain power-driven machines of the ordinary type.

In the above-mentioned lace trade, and also in connection with the particular types of fabrics which have been mentioned as being suitable for this power machine, there are several places on the design where no punching is required on the corresponding rows of the card; these similar numbers or blanks in the lace designs, or the blank masses in the other designs, may extend for several complete blocks, and since there is no alteration required in the lace design, and no weave or mark of any kind on the ground portion of ordinary designs, or of uncut, painted portions in some tapestry designs, there is no ordinary punch to be operated. A punch of some kind, however, is absolutely necessary to impart the desired movement to the withdrawal plate R and to the catches 18 and 18^1 of the carriage; hence, a dummy or spacing punch T, Fig. 156, is introduced, and this punch is operated by the large key 33 at the front of the headstock. Consequently, for all blank rows in the design-paper or their equivalents, it is only necessary to push in the key 33, and the dummy or spacing punch T then fulfils the desired function for the row-by-row movement of the carriage.

Fig. 157 is a more or less diagrammatic view of the keys and punches. The 14 ordinary punches S—two sets of 7—are operated by the 14 keys marked 31 and 32, while the two peg-hole punches 36 are operated by the two keys 37. The operative, therefore, moves the 8 keys 31 at the back of the headstock by his fingers, while his two thumbs control the remaining 8 keys at the front—4 with each thumb.

After all the rows in the card have been cut, it is necessary to break the connection between the catch 18^1 and the teeth of the rack 19, Fig. 154. This is done as follows: Fixed near the right-hand end of the rack 19 is a bracket 38, Fig. 158. The upper surface of the projection of this bracket is inclined as illustrated, and upon this inclined surface rests an antifriction roller 39. The roller 39 rotates on the pin of bracket 40, and is supported by the rod 41, while a light rod 42 is fixed to the bracket. A chain 43

passes over the pulley 44, and connects the rod 42 with the right treadle 45, Fig. 153. Hence, when the right treadle is depressed, the rod 41, Fig. 158, and bracket 40 are pulled to the right, the antifriction roller 39 acts upon the inclined surface of bracket 38, and the rack 19 is caused to descend clear of the catch 18^1, Fig. 154. The carriage may then be pulled forward to any particular row on the cards, or to the starting point near the headstock. When the pressure on the right treadle 45 is withdrawn, the springs 46, Fig. 154, which were extended in virtue of the downward movement of the rack 19 and its supports 47, raise the rack to its normal position.

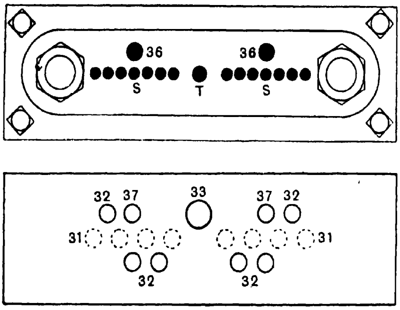


FIG. 157.

It should be mentioned that the cards which have been cut up to the present in the above machine are for use on what is known as the "Lever's lace machine," which is quite different from the machine which is used for the lace-curtain trade. The jacquard machine for the latter fabrics is situated and operated very similarly to those used for ordinary weaving, whereas the jacquard for the Lever's lace machine is at the end of the machine. Its action is also quite different from the usual jacquard in that the holes in the card, or rather the blanks, actuate what are known as "droppers," and these in turn operate a series of steel thread bars. The number of thread bars in the machine varies according to the kind of lace which is being made, and one short row on the card is required for each thread bar. For example, 120 rows on the card are required for 120 thread bars. Moreover, the holes, or rather blanks, in the card have different values according to the distance that the thread bars have to move. The thread bars naturally move according to the pattern, and their movements are in terms of "gaits." Thus, a 10-point machine has 20 gaits per inch; an 11-point machine has 22 gaits per inch, and so on. Three of the holes in each short row of the card represent 8 gaits each, or 8 units of motion; while

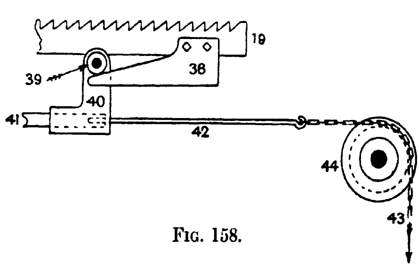


FIG. 158.

the remaining four holes in each short row represent, respectively, 4 gaits, 2 gaits, 1 gait, and $\frac{1}{2}$ gait. Consequently, each short row on the card represents, as a maximum, $31\frac{1}{2}$ gaits. If, say, droppers to the value of 23 gaits are required, the cutter presses in the keys which allow droppers to the value of 23 to be pushed into action with the thread bar. To do this, however, it is necessary to make a mental calculation, thus—

$$31\tfrac{1}{2} - 23 = 8\tfrac{1}{2} \text{ gaits to be cut};$$

and he therefore presses in one key for an 8 gait and one key for $\frac{1}{2}$ gait, which leaves blanks the value of which amount to 23 gaits.

The two cards which are punched at the same time differ in the cutting—one card is for the front motion of the machine, and the other card is for the back motion. Similar mental calculations have to be made for both cards. We shall probably deal more fully with this branch when the time arrives for describing the various types of jacquard machines.

A fairly extensive range of the methods employed for the preparation of jacquard cards by various types of card-cutting machines has been illustrated and described, and it is quite evident that, even at the best, the processes of reading the marks on the design-paper, and the subsequent operations of fingering and stamping, are not only lengthy, but also, on the whole, tedious ones.

So far as the writer's knowledge goes, no really efficient mechanical arrangement has been introduced to supersede this almost universal method of reading and cutting for cards to be used on jacquard looms. With the advent of electricity for industrial purposes the attention of inventive minds was turned, *inter alia*, to that of solving the card-cutting operation electrically, and some very ingenious and praiseworthy efforts were made towards this end. Perhaps the two best-known systems were those known respectively as the Szczepanik and the Zerkowitz—both obviously of Continental origin. An exhaustive account of these systems cannot be attempted here, but it would be inadvisable, in a work of this kind, not to mention these meritorious attempts to solve a difficult problem, especially when it is quite likely that the subject will again claim consideration.

The above two systems have very little in common unless we suggest that the failure of both was due, not so much to the inability of the apparatus to cut the cards, as to the difficulty of preparing the surface from which the electrical contacts were made, and the equally important difficulty of carrying out the combined processes of selecting and cutting at a cost which was low enough to tempt manufacturers and others interested to substitute the processes for those which were established, and which still remain supreme.

Notwithstanding these serious, and at the time effective, drawbacks to the introduction of electrical apparatus, the writer is of the opinion that, with the gradually increasing facilities offered by ever-advancing additions to electrical apparatus, it is quite possible that the combined efforts of electricians, chemists, and textile experts will succeed in placing a practicable electrical card-cutting machine on the market. It was on the advice of the writer that the experiments were discontinued in connection with the Szczepanik system, and this course was not decided upon without a reasonable knowledge of the difficulties which then existed. The scheme was not sufficiently developed to enable the apparatus to compete with the existing mechanical methods ; and besides, at the time, a more important branch was in a higher, though still imperfect, stage of development.

One very serious fault in connection with the introduction of revolutionary-like apparatus is that those directly connected are prone to claim advantages far in excess of the capabilities of the apparatus, even at its best. It is a much safer plan, and one more likely to inspire confidence, to attempt to capture the trade for the simpler work—the other will follow if the apparatus is capable of conducting it satisfactorily, economically, and quickly.

CHAPTER X

READING-IN FRAMES AND CARD-PUNCHING MACHINES FOR LACE, TAPESTRY, AND SIMILAR TRADES

In connection with certain methods of card-cutting and repeating mechanism, the piano card-cutting machine is displaced by a type of "reading-in" frame which is provided with a number of vertical cords or strings equal to the number of needles in the jacquard. Then individual horizontal or cross cords are interlaced amongst the vertical cords in a manner somewhat similar to, but more simply than, that which obtained in connection with the draw-boy jacquard. Thus, Fig. 159 illustrates on a small scale the principle employed. The vertical cords A, equal in practice to the number of needles in the jacquard, are kept separate by means of the pegs or pins B, and the point-paper design placed behind the cords so that the latter may pass over and partially cover the vertical rows of small squares; if necessary, the design can be placed over the cords, and the pins B marked in some way to facilitate the selection of the cords with respect to the painted and unpainted squares of the point-paper design. In some districts the point-paper designs are still mentioned as containing a certain number of cords; this distinction is probably due to the relation between the design-paper and the vertical cords in Fig. 159.

The reader-in places a horizontal cord, say C, Fig. 159, amongst the vertical cords A, according to the marks and blanks of the point-paper design. When this cord C has been inserted, it is slid downwards on the vertical cords A, and a second cord D, for the second pick of the design, is interwoven amongst the vertical cords A. For example, the two cords C and D represent the picking out for the two detached picks immediately under the design.

The reading-in may start either at the top of the design (the last pick) or at the bottom of the design (the first pick). Such a method is employed in connection with the preparation of cards for jacquards used in the manufacture of certain kinds of lace curtains, but, as will be pointed out

shortly, the method for this particular branch of the textile industry is being replaced by more modern processes.

When all the picks of the design have been provided with a corresponding number of horizontal cords, C, D, etc., Fig. 159, the combined cords are taken to work in conjunction with apparatus somewhat similar in principle to the mechanism in Figs. 345 to 349. The sheet of cords in Fig. 159 is placed flat on a table, the upper ends of the warp cords (the original vertical cords A) secured firmly to the table or other suitable support, and the lower ends to another series of cords which are attached to the above-mentioned apparatus. Each cross-cord or pick is then taken separately, and an iron bar inserted in the order amongst the threads; this iron bar is then pressed downwards to draw a number of cords equal to the number under the bar, with the object of preparing a plate of punches similar to those in plate 4 in Figs. 346 to 349.

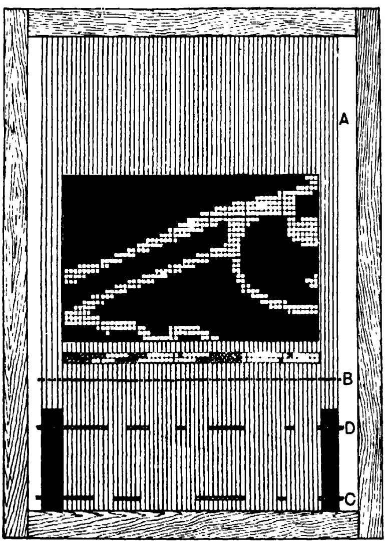


FIG. 159.

This plate of punches is then taken to a powerful punching machine, usually provided with two cranks, which completes the punching of a whole card at a time, and by very similar means to those in connection with Fig. 307, or Figs. 324 to 327—that is, the card is placed between the punching plates, and then the complement of punches forced through the card as the bottom plate is forced upwards by the two cranks.

The lashing or string system of reading-in, as demonstrated in Fig. 159, although being supplanted by more mechanical devices in the lace industry, is extensively practised on the Continent in the preparation of cards for tapestry and other designs on a large number of cords, and in which the weaves used are difficult to insert on point-paper, or difficult to memorise by a card-cutter. When the reading-in is completed, the subsequent operation of punching the cards is conducted in different ways, as demonstrated in Chapter XVIII.; the reader, however, is advised to study the remainder of this chapter, which deals with analogous systems adopted in the lace industry, before considering the application of

the reading-in frames to the elaborate mechanism displayed in Chapter XVIII.

Fig. 160 illustrates one type of mechanism for the purpose as made by Messrs. William Benson, Ltd., Robin Hood Works, Nottingham. The necessary number of vertical strings A, together with their essential cross-cords, constitute the equivalent of the prepared simple illustrated in Fig. 399, and, as already mentioned, the cords for the lace trade are arranged horizontally to facilitate the selection of punches for the card-cutting machine. These two sets of cords are represented in Fig. 160 by the stretch A. The right-hand ends of the cords A are secured to the adjustable bolt B, while the left-hand ends of the same cords are fastened to the cords C; the latter in turn are hooked to the adjustable needles D of the automatic card-punching machine on the extreme left of the figure.

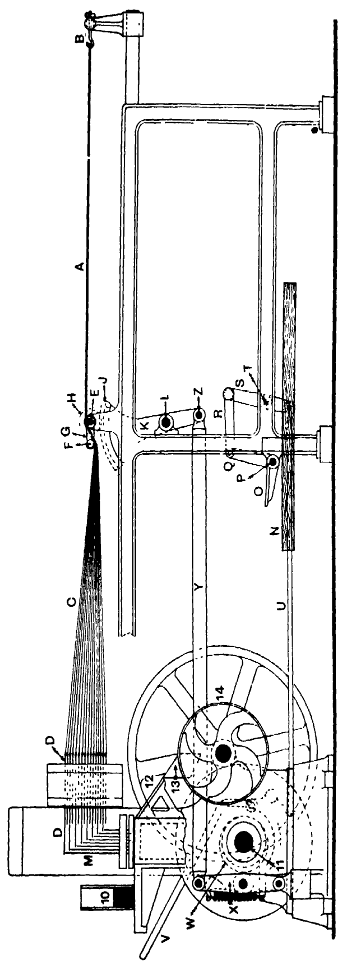


Fig. 160.

Two views of the automatic punching machine are illustrated in Figs. 161 and 162, the former view representing the feed side, while the latter view represents the delivery side. A non-automatic feed machine is also made by the above firm of engineers, and the card-punching machine used for this method is illustrated on the right in Fig. 163. The selecting or reading-in machine which is used in conjunction with the non-automatic card-punching machine is shown on the left in Fig. 163.

In both cases the selection of the necessary cords C, Fig. 160, for each card to be cut is made by apparatus similar to that described. But, whereas one operative can conduct the whole of the work in conjunction with the mechanism illustrated in Figs. 160 to 162, two operatives are

required for half the production of the same class of work with the machine illustrated in Fig. 163. The operative who attends to the latter card-punching machine removes the plate of selected punches from the machine on the left, places it in position on the feed table of the machine on the right, inserts the blank card, and the machine then punches all the required holes in the card at one stroke.

On referring to Fig. 160, it will be seen that all the original vertical cords A pass over a rod E and under a second rod F. The second rod, which is held in the movable bracket levers G (one only shown) fulcrumed

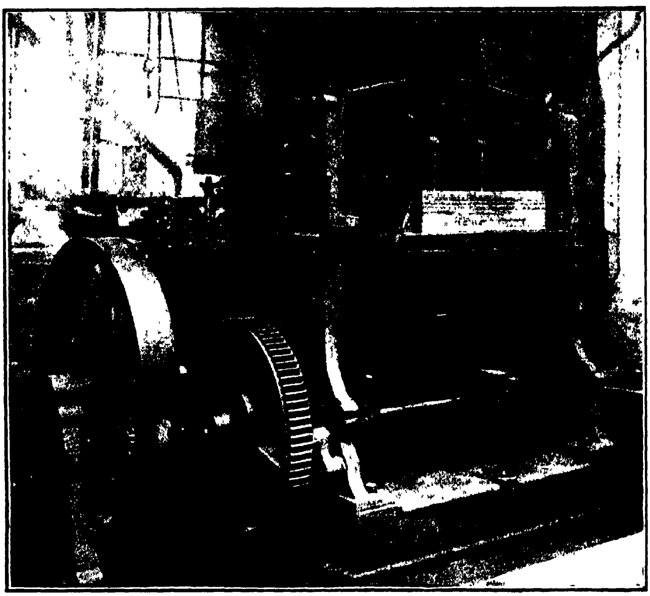


FIG. 161.

at E, is capable of being oscillated through the requisite angle by means of the pinion H and the rack J of the lever K, fulcrumed at L.

The rod F, Fig. 160, is inserted amongst the cords A according to the interlacing of the first cross-cord. Then, when the bracket levers G are moved counter-clockwise the affected cord C will clearly pull the corresponding horizontal needles D clear of the upper ends of the vertical needles M. When the selection has been made by placing the rod F amongst the cords A, the operative, who stands on the platform N, presses down the treadle O fulcrumed at P; this action operates lever Q, link R, lever S fulcrumed at T, and rod U, and this rod, through suitable con-

nections, releases a driving bolt which engages with studs, and causes the machine on the left to make one revolution, after which a cam withdraws the driving bolt. The machine may also be started by means of the handle V. It will be seen that when the machine on the left starts, a cam W, acting on an anti-friction roller X, causes the latter to impart motion to the rod Y, and hence to lever K, since rod Y is attached to the latter at Z. This operation is repeated for every cross-cord, that is, for every pick of the point-paper design. The stretch between the horizontal needles D, Fig. 160, and the rod F is much greater than is represented in the figure.

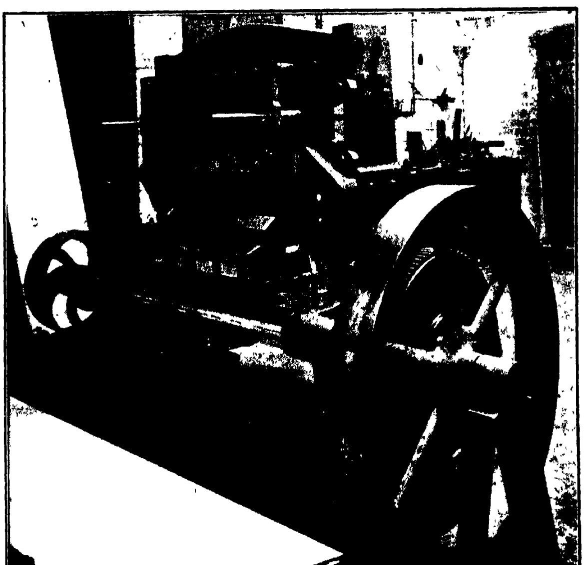


FIG. 162

In Fig. 160, eight vertical needles M only are shown along with a corresponding number of horizontal needles D. The actual construction of these parts differs slightly from that illustrated in Fig. 160, and a better idea of the arrangement will be obtained from the enlarged view in Fig. 164, where the ends of the cords A are shown attached to the hooked ends of the horizontal needles D. These needles are staggered in order to obtain more space, and thus to admit of stronger parts. There are two rows, or 32 horizontal needles D, for each pair of rows of vertical needles M, but 16 of each set only are shown in Fig. 161. But since the next 16 horizontal needles D are midway between those shown, it follows that

the corresponding 16 vertical needles will be rather shorter than the row illustrated; each pair of rows is similar, and around each horizontal needle D is a spiral spring 2, behind which is a pin or collar, so that after

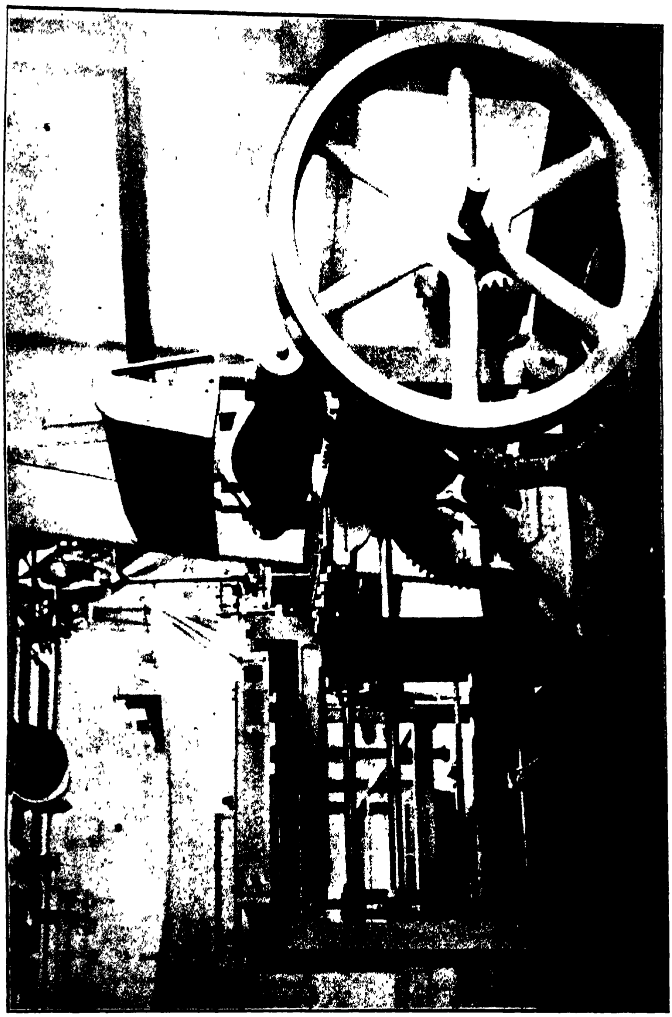


FIG. 163

the horizontal needle has been drawn forward by a cord C, the compressed spring 2 carries it back to its normal position. Suitable guides as shown are provided for both sets of needles.

The actual punches 3 are located in the fixed block 4 and the upper movable block 5, while the card 6 to be punched occupies a position between the upper movable block 5 and the lower movable block 7. The lower block 7 is operated by the cranks shown clearly in Fig. 161, connecting rods 8, Fig. 164, and blocks 9.

As illustrated in Fig. 164, one full row of 16 horizontal needles D is shown with the free ends of the needles over the 16 vertical needles M, and the card 6 is in position between blocks 5 and 7; hence, when the block 7 is raised by the cranks, the block 5 will also be raised, as well as

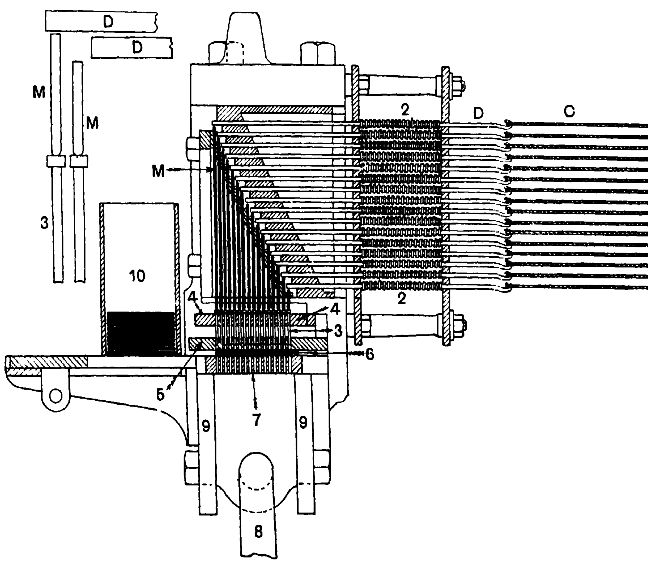


FIG. 164.

the card 6. The punches 3, however, are held stationary by the ends of the horizontal needles D, and, consequently, the lower ends of the punches 3 are forced through the card 6, and enter the holes of the lower block 7, carrying the punched-out discs of cardboard with them. If, however, all the 16 horizontal needles D had been drawn to the right by the movement of the corresponding cords C, Figs. 160 and 164, the upward movement of the blocks 7 and 5, and card 6, Fig. 164, would enable the card to carry upward the punches 3 and the vertical needles M, since under this condition there is nothing to hold the latter firmly in position.

The above description represents two extremes—a full row punched and a full row left blank—but any number of rows or partial rows, in any

order, can be punched or missed as desired. An enlarged detached view of two punches 3, two vertical needles M, and parts of two horizontal needles D, appears in the upper left-hand corner of Fig. 164. The upper needle D is in the active position, while the lower needle D has been withdrawn.

After each card has been cut in the automatic machine, the next card to be cut, the lowest one in the magazine 10, is automatically carried forward, through a slot opposite the lowest card and near the base of the magazine, by means of slides which operate in grooves in the table; these grooves are clearly shown in Fig. 161.

The card is fed in by means of a spring and suitable levers, while a cam on the shaft 11, Fig. 160, withdraws the slides. As the new blank card is being placed in position—that occupied by the card 6 in Fig. 164—it pushes out the newly punched card, and the latter slides down the incline 12, Fig. 160, and drops into the receptacle 13. In Fig. 162, a card newly punched is shown descending the slide 12 towards the other cut cards in the receptacle.

Messrs. Benson's most modern type of apparatus for the preparation of jacquard cards is illustrated in Fig. 165. The automatic card-punching machine on the left is identical with that shown in Fig. 160; the driving pulleys 14 in the latter view are omitted in Fig. 165, but the pitch circle of the small pinion 15 and that of the large wheel 16 on the main shaft 11 are shown.

The difference between the views in Figs. 160 and 165 lies in the method of selecting the horizontal needles D by means of the cords C. In Fig. 165 the cords C play the same part as harness cords in jacquards, and may be tied up to the horizontal needles similarly to harness ties in order to minimise the number of needles and hooks used in the jacquard machine on the right when repetition of pattern occurs.

The cords C are attached to the bottom bends of the hooks 17 of the jacquard; these hooks are arranged horizontally as shown, and the normal positions of their upper or right-hand bends or hooks are off the knives 19 of the griffe 20. A corresponding number of needles 18 are loosely attached to the hooks 17 in order to move the latter on or off the knives 19 of the griffe 20 as desired. The griffe can be adjusted by means of the hand-wheel 21, a pair of bevel pinions, rod 22, and a suitable screw. The lower ends of the needles 18 project through the needle-board 23.

When this apparatus is used the pattern is cut on a common straw-board card by means of a piano card-cutting machine. Then these cards may be fed by a boy on to the 12-sided cylinder 24, which is connected by link 25, bell-crank lever 26, and other rods and levers so as to be operated from a cam on the main shaft 11 of the automatic punching

machine. A somewhat similar arrangement of cam, levers, and rods enables the lever 27 to operate the griffe 20. The machine can be placed in and out of action by the treadle 28, lever 29, and rod 30.

Instead of placing the cards singly on the 12-sided cylinder 24, they may be joined together as at 31, or made into a similar chain by means of gummed tapes, in which case a 4-sided cylinder 32 replaces the 12-sided cylinder 24. When the cards are fed singly on to the latter cylinder, the speed is 20 cards per minute, but when formed into a chain they may be operated at 35 cards per minute by the 4-sided cylinder 32.

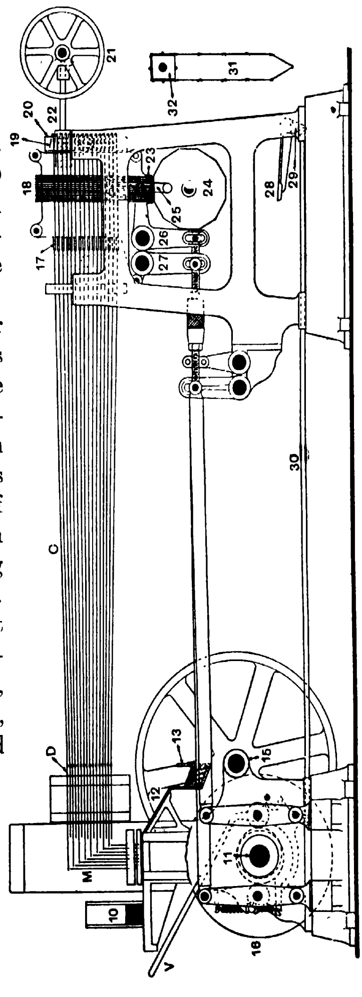
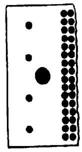


Fig. 165.

Some cards have 14 holes per row, others have 16 per row as indicated. The end of one of the latter is shown detached immediately above the punch press in Fig. 165. Various lengths of cards are used, sometimes 135 rows of 16, or more, or 2160 capacity, with two, three, or four lines of lacing according to the length of the card.

An excellent arrangement is that which embodies the patent reading-in machine by Mr. Archibald Frame, Jacquard Card Puncher, Darvel, Ayrshire, and the above-mentioned automatic punching machine, both of which are made by Messrs. William Benson, Ltd., Engineers, Nottingham. The patent reading-in machine is illustrated in Figs. 166 and 167; the former is a front view, while the latter view shows the two machines coupled up ready for work.



The cords A from the machine illustrated in Fig. 160 are attached to the long left-hand bends of a series of horizontal hooks of a jacquard;

these hooks are shown behind the headstock of the modified piano machine in Fig. 166; the positions of several rows are illustrated, but only the first hook in each row is visible. The cords which bridge the gap between

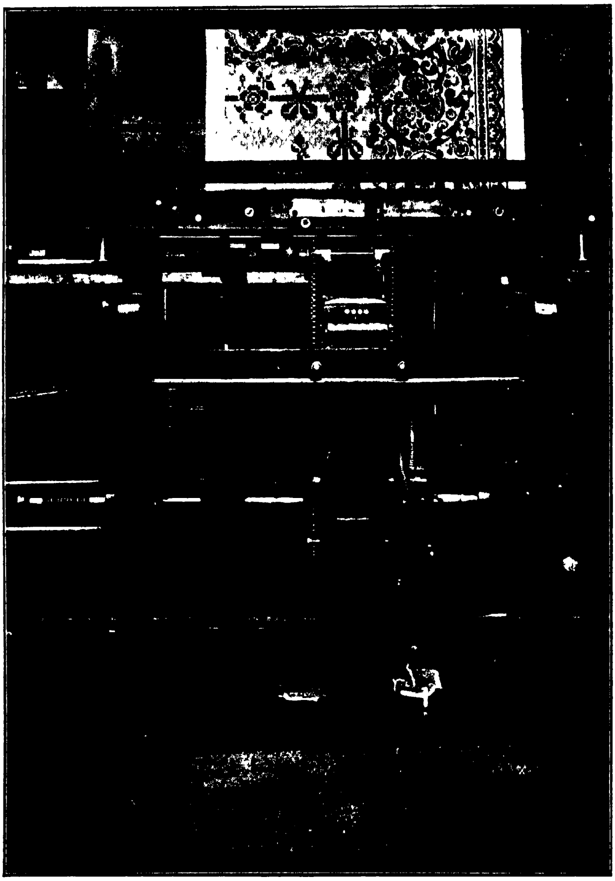


FIG. 166.

the above-mentioned hooks and the horizontal needles of the automatic punching machine are shown clearly in Fig. 167.

The headstock of the machine may have any convenient number of keys, and in the machine illustrated there are 12, of which 4 are at the front and 8 at the back. These keys are operated while reading the design, one short row at a time. Behind the headstock are 12 vertical

rods, each rod being provided with two flat springs behind and with a hinged horizontal arm in front. The horizontal arms are controlled by three-armed punchers or plungers, one arm of which carries the fulcrum,

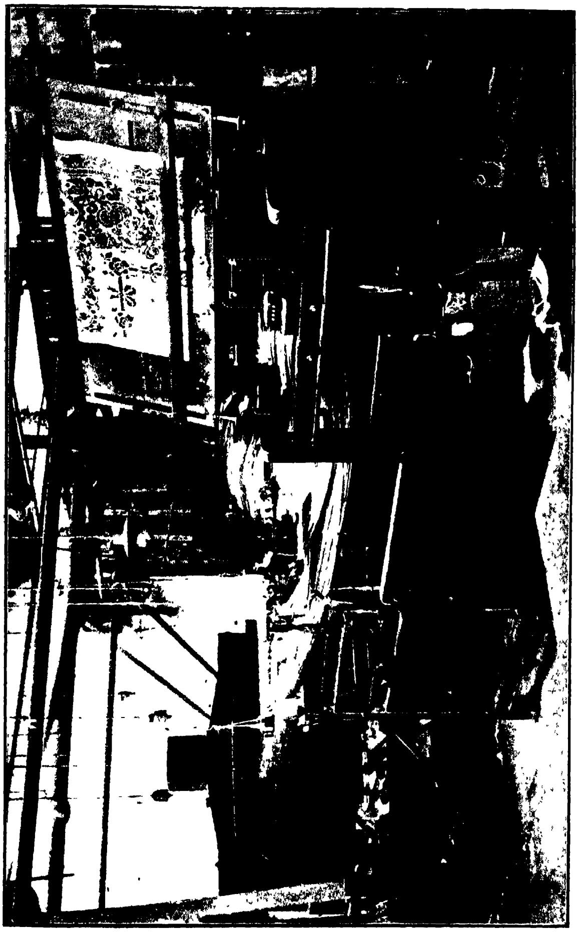


FIG. 167

another is capable of being acted upon directly by the key finger of the headstock, while the third determines whether the hinged horizontal arm shall be clear, or in the path, of a sliding part attached to, or rather moved by, the upper end of a bell-crank lever, the lower arm of which is connected by a rod to the foot-treadle. All hinged horizontal arms which are not depressed (*i.e.* arms corresponding to piano keys not pressed in) are pushed forward by the sliding part, and hence the corresponding vertical rods

are pushed forward in their slides, and returned to their normal positions by their flat springs. The 12 vertical rods act directly on a corresponding number of needles in an intermediate box, and these needles in turn act upon 12 needles (one short row) of a special jacquard, and move their hooks accordingly. These are the hooks shown in Fig. 166, to which the cords are attached.

The intermediate box of 12 needles is attached to two vertical spindles fixed to two light sprocket chains, and the latter are carried by sprocket wheels ; the box is adapted to be moved upwards or downwards as desired by the foot-treadle and connections. Each short row of needles in the special jacquard can therefore have its necessary needles pushed in by the needles of the intermediate box, because the latter moves through the distance between each pair of short rows of needles of the special jacquard. These needles, and the hooks to which they are connected, remain where they have been placed by the needles of the intermediate box until the operative is ready to release them.

In this way the painted and unpainted small squares between each pair of heavily marked lines on the design-paper are recorded, as it were, on the needles and hooks of the special jacquard through the action of the above-mentioned key fingers, three-armed plungers, slide, vertical rods and the needles of the intermediate box. Some of the hooks have their short bends (those on the right) placed over the knives of a griffe, while other hooks are clear of the knives.

When the pick line of the design is completed, the operative touches the connection to the clutch mechanism of the automatic punching machine, when a complete card is cut, after which the card is ejected by the next card taken from the card magazine by the automatic feed mechanism.

CHAPTER XI

LACING AND WIRING CARDS BY HAND

AFTER all the cards for any particular design have been cut and numbered, it is necessary to join them together in such a way that they may be presented in successive order between the faces of the cylinder and the ends of the needles of the jacquard, and so enable the latter, in combination with the hooks, harness, etc., to reproduce the design on the cloth by the correct interweaving of the threads and picks.

The lacing of the cards in the form of an endless chain is absolutely essential, but the operation is often considered as being of secondary importance. This is a mistake, for imperfect lacing may result in imperfect lifts, and in a high percentage of wear and tear in the cards themselves. Carefulness and accuracy are just as essential in this branch as in any of the other branches concerned with the preparation of jacquard cards.

The correct degree of tension should be imparted to all the lacing twines, and at all sections, so that the cards will neither hang loosely over the pegs of the cylinder, nor yet have a tendency to draw each other up above the points of the pegs. Tightly laced cards are more troublesome than comparatively slackly laced ones; efforts, therefore, should be made to lace the cards so that they will drop easily on to the pegs of the cylinder, and not ride on the upper surfaces of the pegs. With constant work the lacing twine stretches slightly, as a rule, particularly if it is made of cotton; but the cards in a loose form fall more easily over the pegs on to the cylinder than do those which are laced too tightly. Sometimes the faces of one or more cylinders are rather deeper than others of the same denomination of machine, and this defect will clearly hinder satisfactory work. In order to counteract this defect, it is a good plan to have each face of the cylinder grooved where the three or more rows of lacing come, so that the cards may fit quite close to the cylinder.

There are two distinct ways of lacing jacquard cards—viz., by hand and by machine. Each method has its advocates, and there are advantages and disadvantages connected with both. It is natural to conclude that

the process of hand-lacing is very much slower than any of the mechanical processes. Although the hand-lacing is such a comparatively slow process, and necessitates a maximum number of knots on the twine, the process on the whole results in a very satisfactory set of cards, particularly if all

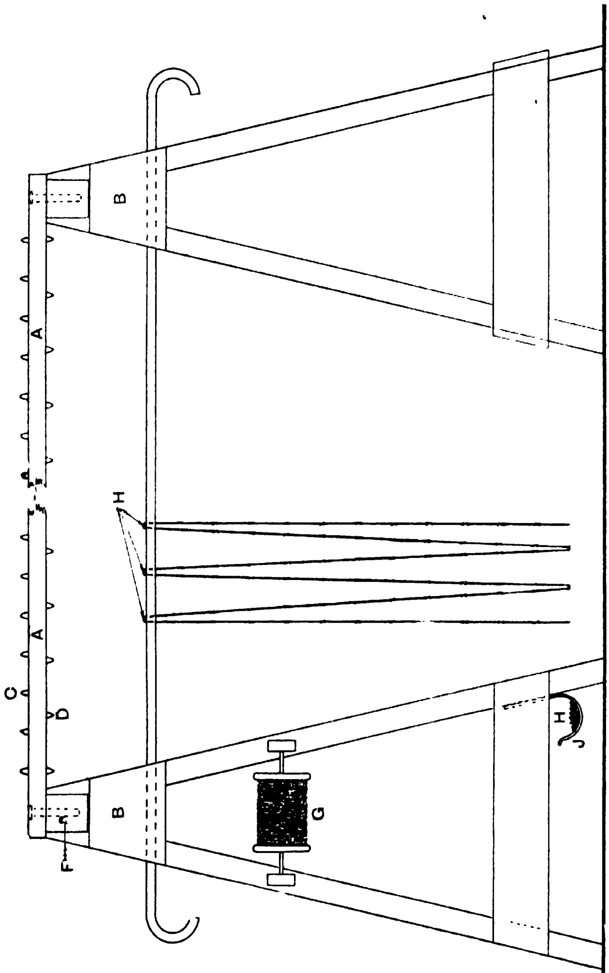


Fig. 168.

the lacing is done by the same person. It is, however, more costly than the machine lacing, but nevertheless it is largely practised by those firms who have not sufficient work to keep a machine employed continuously, and by many who have a considerable amount of lacing to do.

The cards are laced on what is almost invariably termed a "lacing frame." Several forms of these are in use, but the general requirements are such that there is very little difference between the frames themselves, and not much difference between the methods employed for supporting them. Figs. 168 to 170 are illustrative of the simple apparatus which is often used for this branch of the work. Fig. 168 is a front elevation, Fig. 169 is an end elevation, while Figs. 170 and 171 are plans of two different kinds of lacing frames on similar supports.

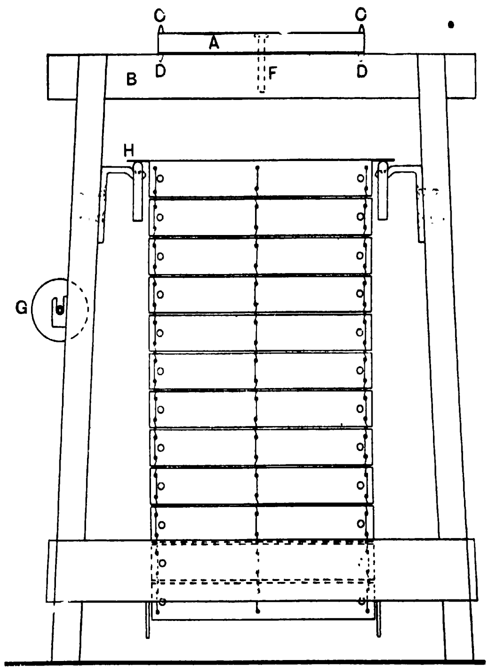


FIG. 169.

The frame A is often made rectangular in form, as shown in Figs. 170 and 171. Two long pieces of well-seasoned wood—say from 8 ft. to 10 ft. long, 3 in. to $3\frac{1}{2}$ in. wide, and $1\frac{1}{8}$ in. to $1\frac{1}{4}$ in. thick—are joined together by end pieces; the distance between the outer edges of the two long boards is slightly less than the length of the cards which are to be laced on the frame. Sometimes the end pieces are omitted, and the two separate long lengths of wood are placed the proper distance apart on the trestles B; this arrangement is often used when there are different lengths of cards to be laced, in order to obviate a multiplicity of frames. Since it is desirable—and, indeed, essential—that each card should be equidistant from its neighbours, it follows that some accurate method must be employed to preserve this constant distance between successive cards. There are two general ways of doing this:

1st. By inserting boxwood or other hard pegs C and D, Figs. 168 and 169, quite close to the outer edges of the two long wooden boards of the frame.

2nd. By inserting broad wire staples E, Fig. 171, equidistant along the two boards of the frame.

The frame as a whole, or the two detached boards if in this form, may be kept stationary by drilling a hole into each end of the frame or boards A, and a corresponding hole into the upper part of each trestle B. Then, by countersinking the hole in the frame A, a loose bolt F may be passed through the frame and into the trestle, so that the head of the bolt is flush with the upper surface of the frame, and hence will offer no obstruction to the free movement of the various lengths of cards when they are being removed from the frame, or when damaged sets are being drawn on to the frame to be repaired.

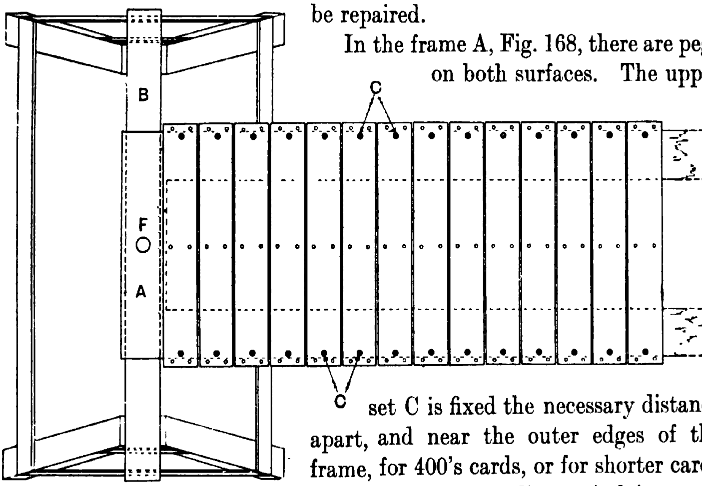


Fig. 170.

In the frame A, Fig. 168, there are pegs on both surfaces. The upper set C is fixed the necessary distance apart, and near the outer edges of the frame, for 400's cards, or for shorter cards belonging to 8-row ordinary pitch jacquard machines. The lower set of pegs D is fixed in a similar way, but sufficiently far apart to accommodate 12-row cards such as are used on most 600's and 900's machines. In Fig. 170 there are 14 cards of the 400's type on the pegs C, while in Fig. 171 there are 2 cards of the 600's type between the broad wire staples. It will be understood that in a similar board to that in Fig. 171, but intended for 400's cards, the wire staples E would be the same distance apart as the pegs C in Fig. 168. In the two views in Figs. 170 and 171 the cards are uncut except with regard to the peg holes for the jacquard cylinder, and the three sets of holes—two in each set—on each card for the three distinct rows of lacing. It will be observed that the two rows of pegs C on the same surface of the frame A are the same distance apart as the two pegs on each face of the jacquard cylinder; hence, if there is any mistake in the position of the peg-

hole on the card, or if the peg-hole should by any chance be omitted, the defect will be quickly recognised when an attempt is made to place the card on the pegs. On the other hand, no such provision is made in the frame which is illustrated in Fig. 171. It is seldom, however, that such mistakes occur even with comparatively inexperienced card-cutters. The chief advantage of the frame with the wire staples is that the cards are quickly placed between the wires before they are laced, and as quickly taken off the frame when the lacing is completed. Both methods are in general use, but the peg frame illustrated in Figs. 168 to 170 is obviously better adapted for keeping the cards in their correct position than is the wire frame in Fig. 171.

A complete hand-lacing frame of American design and manufacture is illustrated in Fig. 172. It embodies, as shown, the lacing frame proper on three substantial metal supports. The two outside supports have adjustable stands for the lacing twine, while the middle support is provided with a double receptacle for the cards which are to be laced.

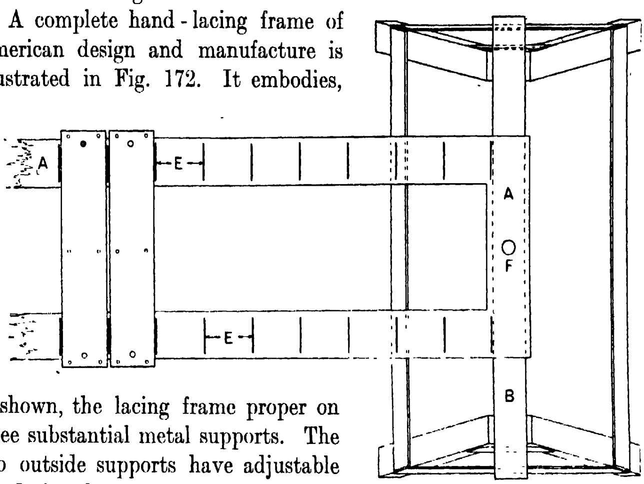


FIG. 171.

There are two distinct methods of placing the cards on the card frame:

1st. With the numbers of the cards facing the observer, and with the first card on the left as illustrated by the four bits of cards marked 1, 2, 3, and 4 in Fig. 173. The operator may naturally start from either side of the frame to set the cards, but if the number on the card is farthest removed from her or him, and the correct way up as illustrated in Fig. 173, the cards are placed for what is technically termed "forward lacing."

2nd. The cards may be placed with card No. 1 on the right hand and the remainder reading towards the left; they are then placed for what is technically termed "backward lacing."

The order in which the cards must be placed on the frames shall receive attention shortly; meanwhile we might assume that they are to be laced

forwards, and as illustrated by the four portions of cards in Fig. 173. First of all, it will be observed that there are two rows only of small holes shown on each card below the large peg-hole. The bottom row in each card is cut for the $^{2}{-}_{2}$ twill for the second row of the jacquard—*i.e.* needles 9 to 16. The upper row of holes on each card is opposite the 6th, 7th, and 8th positions of the first row of the jacquard. The three holes in this first row on each card form a convenient method of dispensing with the necessity

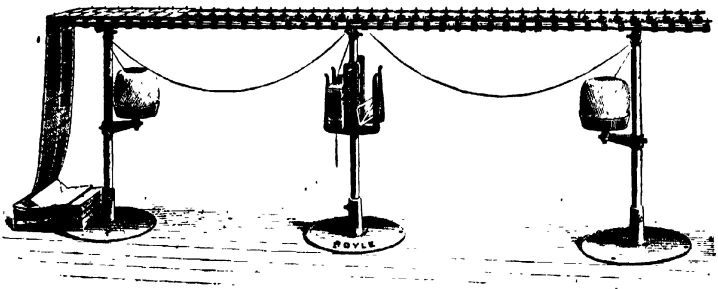


FIG. 172.

for cutting the selvage weave on all the cards for those machines where the selvages must be operated by the card itself. It will be understood that in some machines the selvages are operated direct by the cylinder and special needles and independent of the cards; the needles for this work are never covered by the end of the card, but are nearer the end of the cylinder, and controlled by empty holes or plugged holes according as the needles have to remain undisturbed or be pushed back. The above method of cutting holes on every card opposite those needles which control the

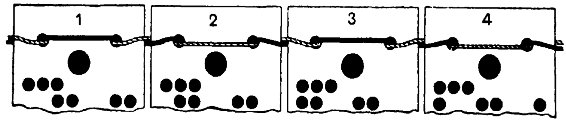


FIG. 173.

selvage threads, and other narrow tapes similar to selvages, is practically equivalent to the independent control of selvage threads; it differs from it only in that no cutting is required for the independent method, while every card must be cut opposite all needles employed for these simple weaves. The holes in the four faces of the cylinder must naturally be arranged to suit the weave required by plugging up the necessary holes—or, what is equivalent, inserting a tack at each of these places. Thus, suppose one single thread at each side of the cloth were required to weave plain merely as a catch-thread, while the adjoining threads—say 12 threads

in the warp at each side—were required to weave in the $\frac{2}{0}\frac{}{2}$ basket or hop-sack weave. The 8th needle might control the plain threads, both the same weave, while the 6th and 7th needles might weave respectively $\frac{2}{}\frac{}{2}$ and $\frac{}{2}\frac{2}{}$, two threads being drawn through each mail or arranged separately, if essential, and each hook controlling twelve threads—six at each side of the cloth. In many jacquard machines there are two rows of spare needles—one at each end— and when this happens the above selvage arrangements might, if desired, be attached to the hooks at both ends of the machine, and thus eliminate crossed harness cords. Four needles would clearly be required if two different threads of the plain weave were required in addition to the basket weave. In this case four holes instead of three would be cut on each card, and the cylinder arranged to suit. This arrangement of cutting all holes opposite the needles for the selvage threads clearly simplifies the cutting, prevents mistakes, increases production in card-cutting, and offers facilities for changing the order of lifting the selvage threads. Suppose, for example, that six needles were utilised for this purpose, two for the plain weave, or for some other convenient order on not more than four picks to the round if two or more colours of weft were used, and the remaining four needles for the narrow tapes adjoining the selvages. Six holes would be cut on every card opposite needles 3 to 8 in the first row; then any simple weave on four threads and four picks could be introduced into the tape portion of the selvage without altering the cards: simply withdraw the tacks and insert them according to the change of weave desired or necessary in that portion which is under the influence of the movements of needles 3 to 8 in the first row of the jacquard.

In each line of lacing, only one line of which is shown in Fig. 173, there are two separate twines, and in order that the method of lacing may be made as clear as possible, these two lines are shown in distinctive markings. The two twines serve two objects: first and foremost, that of joining up the cards into a continuous length; and, second, that of preventing endlong movement as much as possible. For preventing this displacement, or, rather, to minimise it, and to keep the cards in their proper positions, it is an invariable custom to cross the two twines one or more times for each card. In the illustration the twines are crossed only between the cards, and if this is sufficient for any particular set, the lacing is done in perhaps less time than if a different method of crossing were employed.

The operation of lacing shall now be considered in conjunction with Figs. 174 and 175. A suitable length of twine—flax cord, cotton tubing, or other material—is cut off, threaded through the eye of a blunt-ended needle, and then laced into all the holes and between each pair of cards, as is clearly illustrated in Fig. 174. This figure shows six cards for a 600's

jacquard machine, and a single twine is shown in each of the three rows of lacing holes. In practice, however, after one of these twines has been inserted in the manner illustrated, it is usual to lace the companion twine before anything is done with the two remaining rows of holes. The marking for this particular lacing twine is in imitation of twisted threads, while its companion is in solid black; see Fig. 175.

Another length of twine is then cut off and laced through the same holes, and between the cards, but in exactly the opposite way; in other words, the order of interlacing of the two twines is similar to the interweaving of two cutting threads. Although the direction of inserting the second lacing twine is always opposite to the direction of inserting the first lacing

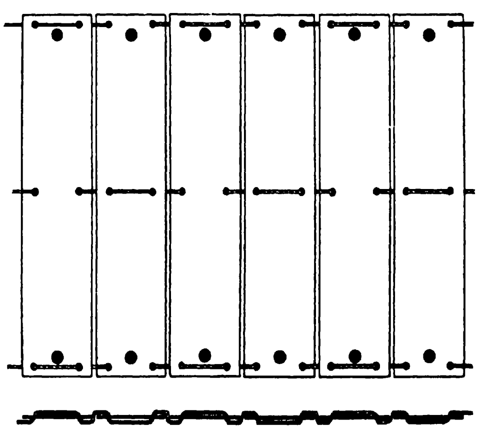


FIG. 174.

twine, the relative position of the former with respect to the latter may vary, as is exemplified in Fig. 175, where three distinct types of lacing are illustrated—two sets, A and B, laced forwards; and one set, C, laced backwards.

In A the solid black twine, or second lacing twine, is crossed from one side of the light twine to the other side every stitch—*i.e.* three times for every card.

In B and C the solid black twine is crossed from one side of the light twine to the other side twice only for each card, the manner of the crossing being plainly shown.

The method of lacing shown at A is certainly better than either of those shown at B or C, since it is calculated to hold the cards more securely in their positions. Not only so, this method of lacing prevents to some

extent the cards from slipping on the laces when the latter break at the loom. If the cards slip or slide on the laces, it is quite evident that the repairs cannot be made at the loom with the same security for future working as obtains when the cards near the broken twines do not slip.

The methods of lacing illustrated at B and C are performed rather more quickly than that shown at A. Methods B and C take the same time if we assume that the black thread is introduced first in B, and the light thread first in C. In the latter figure it will be seen that the light thread occupies the outside position on all the cards, and that the second lacing

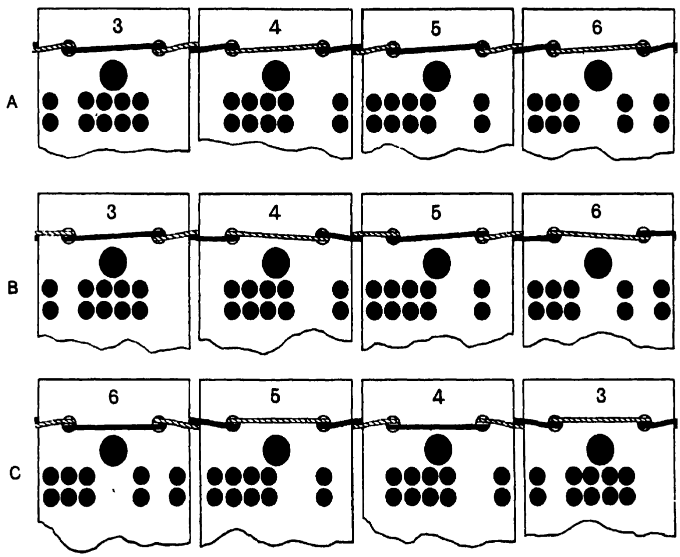


FIG. 175.

twine, the solid black one, occupies the outside position in the opening between each pair of cards; hence, no threading is necessary between the cards—the twine is simply drawn into position between them, and laced on the cards. It is obvious that the lacing at B can be performed similarly, but the twine must be crossed on the card. In A the second lacing twine must be laced between alternate pairs of cards. It need hardly be stated that these remarks refer to the two outside rows of lacing, for in all cases the twines of the middle row, or any intermediate rows, must be laced in every place. Although it is usual to lace each twine separately as indicated, some operatives become so skilful that they can use two needles at the same time, and thus proceed simultaneously with both lacing twines of one row.

All knots made by joining a new length of twine to the end of the finished length should be made on the top of the card, and preferably between the holes on the card; this is the most natural position to tie the ends together, and since no knots are under the card, the latter will be able to lie quite closely to the cylinder when it is in action, particularly if the faces of the cylinder are grooved as previously indicated. The lacing twine may be cut into suitable lengths and suspended ready for use, or it may be used from balls or from a bobbin, as illustrated at G, Figs. 168 and 169 and in Fig. 172. The man on the right in Fig. 127 appears to be wiring a set of cards. These cards, which have been cut, show the three lines of lacing quite distinctly.

Wiring.—Except for very short lengths of cards, it is essential to attach wires to the cards, at suitable distances apart, in order that the ends of the wires may rest upon the rails of the card cradle or support, and thus allow the cards to hang in groups, and also to occupy a minimum amount of room horizontally. The number of cards between each pair of wires depends, first, upon the depth of the card, and, second, upon the height of the jacquard and card cradle from the floor.

In Figs. 168 and 169 the cards are hanging twelve deep—that is, there is a wire H every twenty-four cards. The wires are tied after cards numbered 12, 36, 60, 84, etc., or every odd multiple of 12, and similarly with any other number. Thus, if the number of cards between each pair of wires is $2n$, the wires would be tied after card numbers n, $3n$, $5n$ . . . $(2m+1)n$. The wires may be kept in any convenient and handy place; in Fig. 168 they are shown in a suitable holder J fixed to one of the trestles.

For $16\frac{1}{4}$-in. cards the wires H are about 19 in. long, and although most of them are perfectly straight, they are sometimes made with a cranked part as illustrated in Fig. 176, or else with a similar crank in the middle of the wire. The crank illustrated coincides with the outside row of lacing which is laced first, and this provision clearly enables the wires to be tied so that their ends overhang the same distance, and thus secures uniformity. It also enables all the wires to rest on the sides of the card cradles satisfactorily, and to minimise defective working.

Fig. 176 also illustrates one method of attaching these wires to the cards. Each wire is placed on the top of the lacing between the proper cards while the latter are on the lacing frame. In the illustration the two cards marked A and B are much farther apart than they are in practice, in order that the tying may be more satisfactorily demonstrated. Each wire is tied at three places where there are three rows of lacing, and in general at every row of lacing. The wiring twine, although shown thick in the illustrations, should be thin but tough, and preferably waxed or lightly

tarred, and it should cross the wire and lacing so that the whole will be secure.

At C, Fig. 176, the wire H is shown on the top of the lacing, and the numbers 1, 2, 3, and 4 indicate the successive places into which the needle and cord are drawn. Thus, the needle first passes down at No. 1, then up at No. 2, across the top of the wire, and down at No. 3, and finally up at No. 4. The cord will then be as shown at D. The two ends of the cord are now tied twice on the top, one tie only being shown, at E. If the cards be turned over, the appearance of the under side of the cord will be as represented at F, and it will be seen that the cord does not cross the wire at this side. Nevertheless, the arrangement results in a satisfactory tie.

Another method of tying the wires is illustrated in Fig. 177. At C the

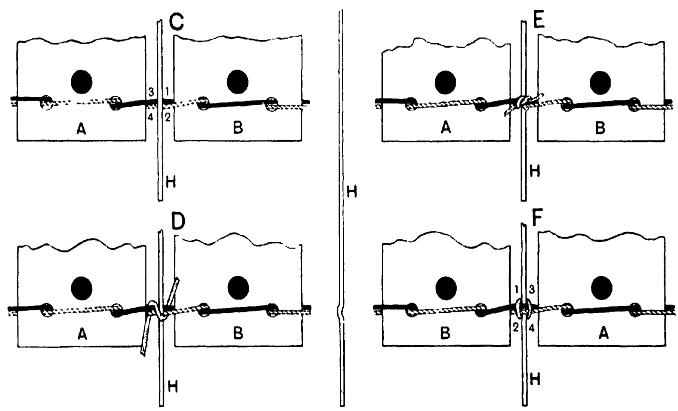


FIG. 176.

first position is shown with numbers to indicate the successive stages of the process. At D the cord, with the needle at the end N, shows that it first passed upwards through No. 1; it is then passed over the wire, down at No. 2, and up again at No. 3, as illustrated at E. The cord then crosses the wire again as shown at F, under the wire alone as depicted at G, after which the two ends, which are clearly at present under the wire, are tied securely at the top of the wire; the knots are not shown. The reverse side of the two cards A and B is shown at H, from which it will be seen that the wiring cord crosses the wire twice. The cord is thus crossed twice both above and below the wire.

As each length of laced and wired cards is finished, it is lifted off the pegs of the frame and deposited neatly in bundle form, the length of the bundle being determined by the positions of the wires. Thus if there are 20 cards between the wires, the bundle will be 10 cards in length.

Occasionally a roller is fixed on the end of each trestle, near the ends of the frame, to facilitate the transfer of cards to or from the frame. In Figs. 168 and 169 the laced and wired cards are suspended on two iron pipes under the frame; this arrangement minimises floor space, but the projecting wires, unless covered, are apt to catch the lacing twine as the operation proceeds.

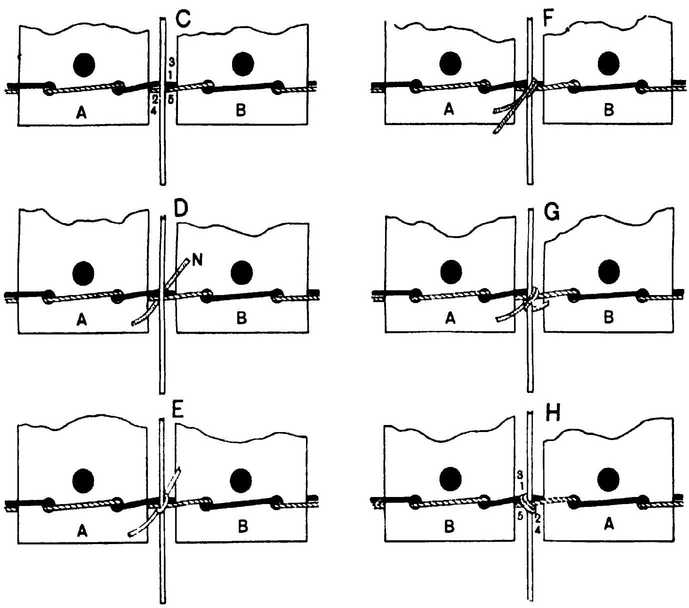


FIG. 177.

It will be gathered from the remarks which have been made, and from a general consideration of the jacquard machine, that the numbered end of the card faces the points of the needles when it is in action, and that the numbered end of the card is near the first row of hooks or the beginning of the 26-row side of 51-row cards. It should be mentioned that in some districts the first row of the jacquard is taken to be that one at the beginning of the 25-row side of similar machines.

CHAPTER XII

THE RELATION BETWEEN THE JACQUARD MACHINE AND THE COMBERBOARD OR HARNESS REED

We have already had occasion to refer to the methods of reading the design and cutting the cards, but in order to supplement the reference and to remove any doubt as to what actually occurs, we introduce in Fig. 178 six small weaves to represent sheets of design paper. The first weave A, in the way of the warp, is the $\frac{4}{2}\frac{1}{1}$ twill to right, and since the small mark * indicates the junction of the first thread and the first pick, it follows that the threads Nos. 1 to 8 of the design are read in the direction of the arrow. When the first thread of the warp is on the left hand of the weaver, and is drawn through a mail in the back row of the comberboard or harness reed, as illustrated in Figs. 3, 5, and 9, the jacquard cylinder and the cards are at the back of the loom over the warp for the Norwich or straight tie. In this case the first hook is governed by a needle in the top row, and the hook is obviously in the back row. When the design A, Fig. 178, is taken to the piano card-cutting machine, it is turned through 180°, and placed on the reading-board in the position indicated at B, and the reading and cutting must be from right to left as shown by the arrow, although the numerical order of reading the rows of the design is clearly still from No. 1 thread onwards. Hence the first pick of the design is at the top in design B, and the straight edge would be immediately under this first pick line, and would be moved downwards after each pick.

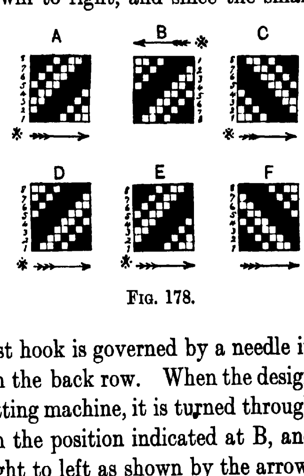


Fig. 178.

If, for the same position of the cards and cylinder in the loom, the cutting starts from the bottom line of B, also from right to left, and the straight edge is moved upwards after each pick, it is clear that the last pick of the design will be cut first, and this card must obviously be

numbered accordingly. For example, the holes and blanks in the two rows on the four cards illustrated at A and B in Fig. 175, reading from the right hand to the left and downwards, correspond exactly with the marks and blanks of the picks 3, 4, 5, and 6 of design B, Fig. 178. The picks appear twice on each card. And evidently the same result could be obtained by cutting the cards in the order 6, 5, 4, 3, and arranging them as in Fig. 175. Consequently, when this or any other design is fixed on the reading-board, the cards may be cut in either of the following orders :

1, 2, 3, 4 . . . . $(n-2)$, $(n-1)$, n
n, $(n-1)$, $(n-2)$. 4, 3, 2, 1

—provided that care is taken to number the cards accordingly, so that they may be placed on the lacing frame in the order indicated at A or B, Fig. 175, or as in Fig. 173.

If, however, the same jacquard be placed on the loom in such a way that the cylinder and cards are at the front—that is, over the weaver's head—the first needle will be in the top row, but the hook which it governs will now be in the row at the front of the loom, and on the right-hand side of the weaver; consequently the first needle and first hook of the machine will operate in reality the last thread of the warp, provided that the cloth is woven face side uppermost in the loom. At this stage it is assumed, for the sake of simplicity, that all the cloths are woven face upwards.

Now if the cards shown at A and B, Fig. 175, were operating the needles of the jacquard with the cylinder and cards at the front of the loom and over the weaver's head, as illustrated in Fig. 43, the twill and all the ornament of the design would be reversed in direction. Thus, the effect on the cloth would no longer be as illustrated at A, Fig. 178, but would appear as shown by design C in the same figure. It will be noticed that the order of movement in the threads in both designs A and C is ${}^{4}{}_{2}{}^{1}{}_{1}$. Suppose, however, that the same eight cards (the middle four only of which are illustrated in Fig. 175) were laced backwards, that is, placed on the lacing frame so that the numbers would read 8, 7, 6, 5, 4, 3, 2, 1, from left to right, or in the order indicated by the four cards at C, Fig. 175, it will be found that the result in the cloth is identical with the design D, Fig. 178. This alteration will obviously have caused the twill to move to the right as in the original design A, but the movements of the threads in the two designs are different. Thus :

Each thread in design A is of the order ${}^{4}{}_{2}{}^{1}{}_{1}$, but
" " " D " " ${}^{4}{}_{1}{}^{1}{}_{2}$.

Evidently, then, the design on the cloth in the loom would be incorrect if viewed from the position occupied by the weaver. On the other hand, if

the cloth when removed from the loom were turned end for end—*i.e.* through 180°—the last pick inserted, or pick No. 8 of the design D, would be nearest the observer, and the effect in the cloth would then appear as indicated by the design E, Fig. 178, which is precisely the same as the original design A.

If, therefore, the cards which have been cut from the original design (say the twill A, Fig. 178) are laced backwards, and the first inserted pick considered, as it actually would be, the last horizontal line or pick of design A, the result in the cloth would remain unaltered, provided that the cloth is turned through 180°. The actual last thread of the warp would then become the first thread of the cloth. Hence, if all the threads of the warp are of the same count and colour, or if the colour scheme and threads are in the same order from the two selvages, any set of cards can be used as under:

1. Laced forwards when the cylinder and the cards are over the warp at the back of the loom, as in Figs. 10 and 44.
2. Laced backwards when the cylinder and the cards are over the weaver's head at the front of the loom, as in Fig. 43.

Similarly, if the cards which were cut from the design B, Fig. 178—*i.e.* design A turned through 180°—were laced backwards and placed on the loom with the cylinder and cards over the warp, the direction of the twill would be reversed, and would appear on the cloth as exemplified by the design F, Fig. 178. The order of the movements in this design is $^{4}{}_{1}{}^{1}{}_{2}$, but when turned through 180° it is $^{4}{}_{2}{}^{1}{}_{1}$, and identical with the design C.

Now suppose that the harness is drawn in with the first thread of the warp—that on the left hand of the weaver—in the front row of the comber-board or harness-reed, as in the lower diagram in Fig. 3, and that the cards and cylinder are at the back of the loom over the warp. The first needle in the jacquard would now be in the bottom row of the machine, and the first hook would naturally be in the front row over the weaver's head. In this case the design A, Fig. 178, would be placed on the reading-board in the same position as it appears in the illustration, and the reading and cutting would proceed from left to right. The straight edge would then be brought into line with the first pick—that is, under the first or bottom horizontal line of small squares of the design A, Fig. 178, and would be moved upwards one pick after each card was cut. The cards would be numbered 1, 2, 3, 4 . . . *n*, and it is clear that with this arrangement all the horizontal rows of small squares which had to be cut would be in sight—that is, not covered by the straight edge.

In a similar manner to that already described with reference to the loom where the draft of the harness is from back to front, it is also

necessary, when the harness is drawn from front to back, and when the cards occupy a position over the weaver's head, to have the cards from the design A, Fig. 178, laced backwards, 8, 7, 6, 5, 4, 3, 2, 1, in which case the effect on the cloth in the loom would be identical with the design shown at B, which is obviously a very similar effect to that shown in design A, and exactly the same if the design is viewed from the opposite end. The effect in the cloth would again be quite correct, if we consider the right-hand thread in the warp as the first thread with the cloth turned through 180°.

To illustrate still further the connection between the various points of the design and the needles, hooks, and threads of the loom, we shall assume that all the warp threads are white and that all the weft threads are black; this assumption will help considerably in regard to the consideration of the ornament on the upper and the lower surfaces of the cloth. Fig. 179 illustrates the ornament which is enclosed in the section B E in Figs. 108 and 109, with the exception of a small square area in each corner; in these corners we have inserted the numerals 1, 2, 3, and 4. The correct view of the lion rampant obtains, of course, when Fig. 179 is turned 90° counter-clockwise; the position illustrated, however, is correct so far as the design in Fig. 108 is concerned. The ground part of some point-paper designs is coloured and the figure left unpainted; in most cases, however, it is usual to paint the ornament and leave the ground in the natural colour of the paper. This has been done in Fig. 179, although it is on plain paper and not on design paper; the method therefore coincides in principle with that which was followed in the preparation of the actual point-paper design for Fig. 108.

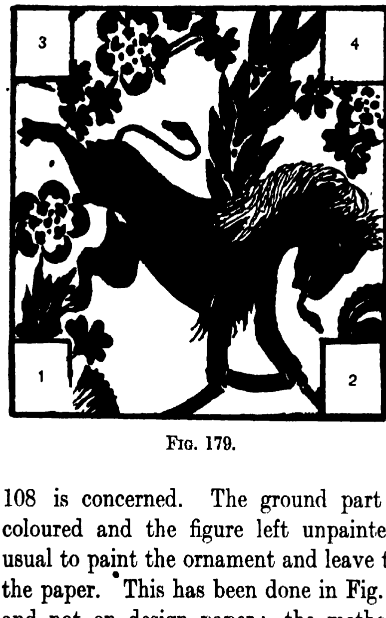


FIG. 179.

When two distinct shades of yarn are used in weaving, it is, in general, better to employ the light-coloured yarn for the warp and the dark-coloured yarn for the weft: there are occasions when the reverse may be necessary. If the light-coloured yarn were used for warp, and Fig. 179 were transferred to design paper, the upper surface of the cloth would have a lion rampant developed in light warp on a dark ground, because painted areas

on the design paper are usually, although not invariably, cut to indicate warp threads on the upper surface of the cloth in the loom.

It has been stated elsewhere that damask designs, as well as several other types of designs, are woven face downwards, hence with light-coloured warp and dark-coloured weft the under side of the cloth in the loom woven from Fig. 179 would be represented by a dark figure on a light ground, because the figure would be developed by the dark weft. It will be found to be more convenient for demonstration purposes to reverse the method of painting, but before doing this we shall consider the disposition of the jacquards and comberboards.

With the Norwich or straight tie, the jacquard cards and the cylinder may occupy, as already mentioned, one of two positions, viz.:

1. At the back of the loom, where the cards would hang over the warp threads.
2. At the front of the loom, where the cards would hang over the woven cloth or above the weaver's head.

With the London tie, or quarter-twist tie, the jacquard cards and the cylinder are always at one or other end of the loom.

The positions of two groups of jacquard looms, four in each group for the Norwich tie, are illustrated in Figs. 180 and 181. In these diagrams the rectangles A, B, C, D, E, F, G, and H indicate the bottom board of the jacquard machine, while the narrower rectangles *a*, *b*, *c*, *d*, *e*, *f*, *g*, and *h* indicate the respective cylinders. The comberboards are under the bottom boards of the jacquards, and since the long sides of the comberboards and the long sides of the bottom boards of the jacquards are parallel to each other, it follows that the diagrams represent the Norwich or straight tie. The set-on handles for the eight looms are represented by two groups of solid circles S, four in each group, which therefore indicate the positions of the driving pulleys. Occasionally, and particularly for certain wide looms, there are pulleys at both ends, but the above disposition represents the usual arrangement for the bulk of looms.

In 51-row jacquard machines it is customary to have 26 rows of needles and hooks in one section and 25 rows in the other section, and when viewing the cylinder in the direction of the arrows in Figs. 180 and 181, the 26 row is on the right-hand side—*i.e.* where the small letters *a* to *h* are situated. The actual positions of No. 1 needle, hook, and thread depend upon custom, and vary in different districts.

In the first place, the threads of the warp may be drawn through the mails of the harness cords in two distinct ways:

1. From the back row of the comberboard or harness-reed to the front row, as exemplified in Fig. 180.

2. From the front row of the comberboard or harness-reed, as shown in Fig. 181.

The holes in the comberboard (eight in the illustrations for a 400's or

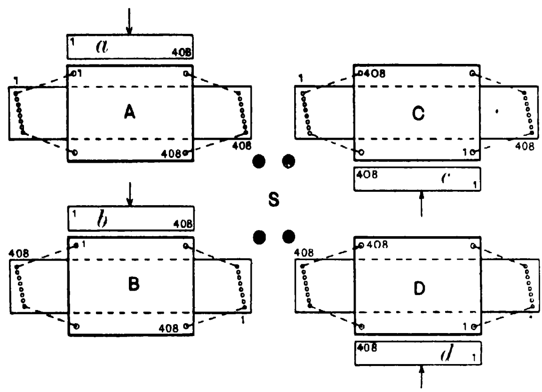


FIG. 180.

8-row machine, actual number 408 needles and hooks) are shown at an angle for clearness only ; it will be understood that they appear practically, and in most cases absolutely, straight in practice. The order chosen makes no difference, of course, to the position of the outside threads, but

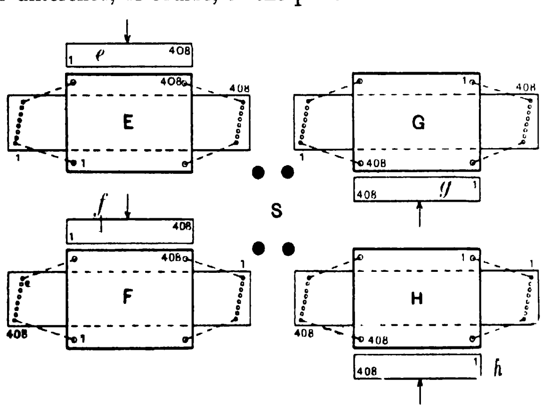


FIG. 181.

the two methods of drawing the threads demand attention and care in connection with all other parts and operations.

In the eight diagrams in Figs. 180 and 181 we have marked the positions of the first and last hooks (Nos. 1 and 408) in the machines, while the

corresponding positions of the holes in the upper face of the cylinders are also indicated by similar numbers. The dotted lines from the machine to the comberboard show which threads of the warp are controlled by the needles and hooks. Thus :

In looms A, D, E, and H, No. 1 hook controls No. 1 thread.
„ B, C, F, and G, „ 1 „ „ No. 408 „

Fig. 1 shows the disposition of the chief parts of the jacquard as illustrated in looms A, D, E, and H, Fig. 180, while Fig. 2 shows the disposition of similar parts as illustrated in Fig. 181. The letters C and W in Figs. 1 and 2 indicate respectively the positions of the cards and the weaver; they are on opposite sides of the comberboard in Fig. 1, but on the same side of the comberboard in Fig. 2.

Figs. 182 to 189 have been prepared specially to demonstrate the alterations which take place in the delineation of the ornament illustrated in Fig. 179, according to the position of the jacquard cylinder with respect to the loom, and to the method of cutting and lacing the cards. The illustrations, with the explanations, might constitute a scheme of instructions for cutting cards from different types of designs and for differently arranged looms.

The reader is asked to consider these figures as representing point-paper designs as well as representations of woven effects in the cloth, and, for simplicity, to consider each separate figure as occupying all the threads of the warp, unless otherwise stated. We might, for example, consider that each illustration is to occupy 408 threads, so that the number may correspond with that in the comberboards of Figs. 180 and 181.

The ornament in Fig. 182, with the exception of the size of the four numerals, is identical in outline with that in Fig. 179; it differs from it in that the black and white masses have changed places, and the numeral 3 has been altered in shape in order to make it unsymmetrical in all ways. Assuming that figured portions on the point-paper design had been left unpainted, and the ground portions painted as in Fig. 182, and that unpainted masses had been cut on the cards, it is clear that the ornament would be developed on the surface of the cloth with the white warp threads, and the ground of the fabric developed with the black weft.

Consider first the case where the cards have been cut and used on the cylinders of looms A and D, Fig. 180, with the face side of the cloth upwards in the loom. In these two looms the first thread of the warp is on the weaver's left; while the last, or 408th, thread is on the weaver's right. If, while cutting the cards, the point-paper design in Fig. 182 were upside down, and the lines were read from right to left, the woven effect on the upper side of the cloth in the loom would be identical with Fig. 182, and

the numerals, as well as the remainder of the ornament, would be correct. By lacing the cards backwards the effect would be altered to that illustrated in Fig. 183; and although the lion rampant and the floral ornament would change only in direction if the cloth were turned through 180°, it will be evident that the numerals are also changed, and would consequently be quite wrong. Indeed, if we imagine that Figs. 182 to 185 represent one complete cloth in which the harness is centre-tied exactly at the middle,

Fig. 182.

Fig. 184.

Fig. 183.

Fig. 185

and the cards rotated forwards for half the number of picks and then backwards for the remaining half, we see a further demonstration of the case which has already been fully discussed in connection with Figs. 35 to 37, where it was shown that letters, numerals, and the like, which do not happen to be symmetrical, should be developed only by single and repeating ties, and not by centre-tied harness, nor by the combination of forward and reverse working of the cards.

Now consider the same set of cards used on the cylinders of looms B and C, Fig. 180. In these two looms the extreme right-hand thread of

the warp, that on the weaver's right, although marked 408, is really the first thread, because it is operated by No. 1 needle and hook, while the extreme left-hand thread is the last thread, because it is controlled by No. 408 needle and hook; hence the direction of all the ornament in Fig. 182 would be reversed on the cloth, and would appear as in Fig. 184. This shows conclusively that, although the animate and floral ornament might be acceptable, the numerals are all wrong. If, however, the same cards are laced backwards, the order of all the picks in Fig. 184 would be reversed, and the effect in the cloth would be identical with Fig. 185. This figure is, of course, upside down; but if the cloth be turned through 180°, the effect presented is precisely the same as that in Fig. 182. It will be understood that the above remarks refer, as already intimated, to a self-coloured warp; if differently coloured threads were required to develop the various parts of the design, the order of the colours in looms B and C, Fig. 180, would be reverse to that in looms A and D, in order that the weave structure and the colour scheme may work in unison.

From the above remarks it will be seen that if the cloth is woven face uppermost in the loom, the conditions are—

Cloth woven face upwards in loom. Design upside down on reading-board and cards cut from right to left.	A. The cards should be laced forwards when the cylinder and the cards are over the warp beam at the back of the loom, as at A and D, Fig. 180. B. The cards should be laced backwards when the cylinder and the cards are over the weaver's head at the front of the loom, as at B and C, Fig. 180.

We might, again, consider that Figs. 182 to 185 represent a complete cloth with the figures on the upper side of the cloth in the loom developed by white warp on a black weft ground. When such a cloth, composed of simple weaves and of single structure, is turned over from left to right, or *vice versa*, to exhibit what was the under side of the cloth in the loom, the result is obviously black weft figures on a white warp ground, as depicted in Figs. 186 to 189, the selvages having changed sides. The four designs in Figs. 186 to 189 are really exactly the same as those in Figs. 182 to 185, with the black and white masses changed, but it is the point of view of the front and back of the fabric that should claim sole attention here.

Suppose, for example, that the cloth upon which the figures are displayed should be woven face downwards in the loom, and that the design on the face side should be black weft on a white warp ground. To simplify matters again, consider only the ornament in Fig. 186 as being the correct design but on the under side of the loom, and that the cards had to be cut from the point-paper design represented by Fig. 182, unpainted portions of Fig. 182 being cut as before. With these conditions, and the cards cut from right to left as previously with the design turned through 180° on

the reading-board of the card-cutting machine, we should have developed on the upper surface of the cloth in looms A and D, Fig. 180 :

1. The effect in Fig. 182 when the cards are laced forwards.
2. „ „ „ 183 „ „ backwards.
The reverse surface of Fig. 182 is that shown at Fig. 188.
„ „ „ „ 183 „ „ Fig. 189.

Fig. 186.

Fig. 188.

Fig. 187.

Fig. 189.

If now Fig. 189 be turned through 180°, the ornament and numerals would appear exactly the same as the ornament and numerals in Fig. 186, and precisely the same as the corresponding parts in Fig. 182, but black and white masses would have changed places.

With the same conditions, and the cards again cut from right to left from the design in Fig. 182 inverted, we should have on the upper surface of the cloth in looms B and C, Fig. 180 :

3. The effect in Fig. 184 when the cards are laced forwards.
4. „ „ „ 185 „ „ backwards.
The reverse surface of Fig. 184 is that shown at Fig. 186.
„ „ „ „ 185 „ „ Fig. 187.

And the ornament and numerals in Fig. 186 are exactly the same as those in Fig. 189 when the latter is turned through 180°, and just the same as the corresponding parts in Fig. 182, but black and white masses have changed places.

It would thus appear that if the point-paper design corresponding to Fig. 182 is inverted on the reading-board, and the cards are cut from right to left from unpainted portions, the under surface of the cloth in the loom is correct under the following conditions:

Cloth woven face downwards in loom. Design upside down on reading-board and cards cut from right to left.

- C. The cards should be laced backwards when the cylinder and the cards are over the warp beam at the back of the loom, as at A and D, Fig. 180.
- D. The cards should be laced forwards when the cylinder and the cards are over the weaver's head at the front of the loom, as at B and C, Fig. 180.

In some linen damask factories where the cloths are woven face downwards, all the cards for mottoes, names, and the like are laced backwards (and not forwards as mentioned in part D), and the cloths woven in looms in which the cylinder and the cards are over the weaver's head. In such cases, however, the design is made for the right-hand corner of the cloth—that is, similar to the effect in Fig. 184 instead of as Fig. 182—and the design placed the right way up on the reading-board. The use of the same type of loom, with reference to the position of the cylinder, is the practice adopted with the object of preventing any alteration in the lacing of the cards. In other factories, on the other hand, such cloths are woven in any suitable loom which happens to be at liberty, and the cards laced according to the position of the cylinder of the jacquard with respect to the loom.

It will be seen that no alteration in the relative positions of the parts of the design will take place whether the figure or the ground of the design is painted on the point-paper; the ground was assumed to have been painted in the foregoing description. If, however, we assume black warp and white weft, with figure parts painted on the design-paper, the results will be identical with those described in the foregoing discussion. It is only in special cases or special types of designs that the painting has anything to do with the actual colour scheme of the warp or weft. As a matter of fact, both warp and weft are the same colour in a great number of figured cloths.

As already stated, the foregoing description has reference to the case where the design is turned through 180°, and therefore placed upside down on the reading-board of the piano card-cutting machine, as exemplified in the diagram in Fig. 190. Hence, the actual first pick, or first horizontal line of the design, is at the top, and, if the cards are cut in the natural order of numbering, the horizontal straight-edge would be moved down-

wards in the direction of the arrow A as the cutting proceeded. The direction of reading and cutting was taken to be from right to left as indicated by the arrow B.

If, however, the design be placed the right way up on the reading-board of the piano card-cutting machine, as indicated in the diagram in Fig. 191, the first pick or first horizontal row of small squares would clearly be at the bottom, and the straight-edge may be moved upwards, line after line, as indicated by the arrow C. It need hardly be said that the straight-edge may be moved either up or down for either disposition of the point-paper design, and according to which arrangement happens to be suitable for the operator; the only thing to remember is that the numbering of the cards must correspond to the numbers of the picks. In both cases, as demonstrated in Figs. 190 and 191, the numbering would

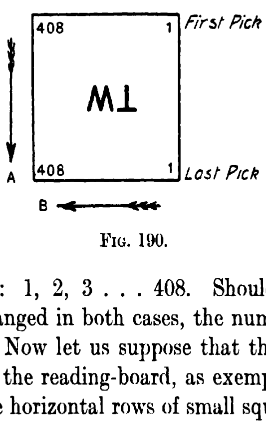


Fig. 190.

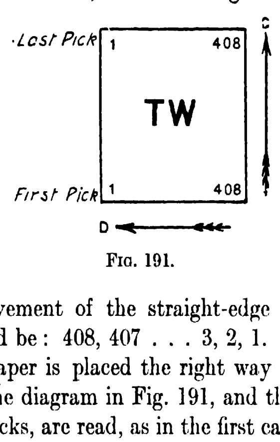


Fig. 191.

be: 1, 2, 3 . . . 408. Should the movement of the straight-edge be changed in both cases, the numbers would be: 408, 407 . . . 3, 2, 1.

Now let us suppose that the design-paper is placed the right way up on the reading-board, as exemplified in the diagram in Fig. 191, and that the horizontal rows of small squares, or picks, are read, as in the first case, from right to left as indicated by the arrow D; everything would be reversed as compared with the results from the other diagram, and we should have the following:

Cloth woven face upwards in loom. Design right side up on reading-board and cards cut from right to left.

- E. The cards are laced backwards when the cylinder and the cards are over the warp beam at the back of the loom, as at A and D, Fig. 180.
- F. The cards are laced forwards when the cylinder and the cards are over the weaver's head at the front of the loom, as at B and C, Fig. 180.

And

Cloth woven face downwards in loom. Design right side up on reading-board and cards cut from right to left.

- G. The cards are laced forwards when the cylinder and the cards are over the warp beam at the back of the loom, as at A and D, Fig. 180.
- H. The cards are laced backwards when the cylinder and cards are over the weaver's head at the front of the loom, as at B and C, Fig. 180.

The complete particulars for both kinds of looms in Fig. 180, and for right to left cutting of the cards, appear in Table V.:

TABLE V.

Cloth Woven FACE UPWARDS.	Looms A and D.	Looms B and C.
DESIGN UPSIDE DOWN ON BOARD:		
Direction of reading design . . .	RIGHT TO LEFT.	Right to left.
Method of lacing cards	FORWARDS.	Backwards.
Order of coloured threads in the loom .	LEFT TO RIGHT.	Right to left.
DESIGN RIGHT SIDE UP ON BOARD:		
Direction of reading design . . .	Right to left.	RIGHT TO LEFT.
Method of lacing cards	Backwards.	FORWARDS.
Order of coloured threads in the loom .	Right to left.	LEFT TO RIGHT.
Cloth Woven FACE DOWNWARDS.	**Looms A and D.**	**Looms B and C.**
DESIGN UPSIDE DOWN ON BOARD:		
Direction of reading design . . .	RIGHT TO LEFT.	Right to left.
Method of lacing cards	BACKWARDS.	Forwards.
Order of coloured threads in the loom .	LEFT TO RIGHT.	Right to left.
DESIGN RIGHT SIDE UP ON BOARD:		
Direction of reading design . . .	Right to left.	RIGHT TO LEFT.
Method of lacing cards	Forwards.	BACKWARDS.
Order of coloured threads in the loom .	Right to left.	LEFT TO RIGHT.

When the warp contains differently coloured threads the arrangement in small capitals appears to be the best, because the order of warping the coloured threads need not be altered to suit the changed conditions in the loom. If, however, all the threads of the warp are the same colour, as in many types of linen, cotton, and silk figured fabrics—*e.g.* damasks—the simpler way when changing from looms A and D to looms B and C is to use the same or a similar set of cards, but to lace them backwards. The great advantage of the latter method is that the same set of cards can be utilised for both kinds of looms when the cards are laced in the correct order, whereas in the other method it is necessary to consider the relation between the colours of the threads and the positions of the needles and hooks which control them. It is of course just as easy to cut the cards with the design one way on the board as the other way; and if one loom only had to be provided with a set of cards, there would be little to choose between the methods. On the other hand, however, if several looms were to be engaged on the same pattern, and with self-coloured

warps, a distinct advantage would obtain when one set of cards only had to be cut on the piano card-cutting machine, and all the remaining sets prepared on the card-repeating machine, using this first set as a pilot set.

When the designs are comparatively short in the way of the weft, and two sets of cards for different looms can be accommodated between two ordinarily pitched looms, and the cards therefore always arranged over the warp beams, the above-mentioned difficulties never appear; but there is not sufficient space for two very long sets of cards between ordinarily pitched looms; indeed, there is often little enough space for the cards for one design and loom, and particularly is this the case for certain types of cross-bordered fabrics and the equivalent of such—*e.g.* those illustrated in Figs. 37, 39, 40, and 41. For work of this kind two sets of cards are invariably required, each set containing hundreds of cards.

The method of drawing the warp threads from back to front of the comberboard or harness- reed, as illustrated in Fig. 180, is practised in many centres where jacquard weaving is extensively conducted; in other centres the method of drawing in the threads is that illustrated in looms E to H, Fig. 181. For such an arrangement of draft it is usual to read the design from left to right when cutting the cards, because the bottom needle of the jacquard—that which controls the hook marked No. 8 in Fig. 1—controls the thread nearest the weaver. And since the draft in the harness is reversed, and the order of cutting is reversed as exemplified in Figs. 190 and 191, the above particulars will do for both orders.

The various positions of the needles and hooks relative to the comberboard or harness-reed, and with respect to the two methods of drawing the warp threads through the mail of the harness in conjunction with the Norwich or "Straight" system of harness tie, are illustrated fully in Figs. 180 and 181. With the London or "Crossed" tie, in which the harness cords have a quarter twist, the long sides of the jacquard and cylinder are at right angles to the long sides of the comberboard or harness-reed, as exemplified in Figs. 192 and 193; eight different diagrams are again exhibited. The first four (J, K, L, and M in Fig. 192) are typical of the back-to-front method of drawing in the threads, while the remaining four (N, O, P, and Q, Fig. 193) are representative of the front-to-back method of drawing in the threads. If we place the 16 diagrams from Figs. 180, 181, 192, and 193 as under—

A	B	C	D	E	F	G	H
J	K	L	M	N	O	P	Q,

we may assume that to all intents and purposes the two in each vertical row are identical. Thus if we examine the position and numbers and the method of drawing in the threads in diagram A, Fig. 180, and compare

these with the corresponding parts of diagram J, Fig. 192, we shall find them exactly the same. Further, if we assume that the bottom board of the jacquard A, Fig. 180, is turned one-quarter counter-clockwise, the

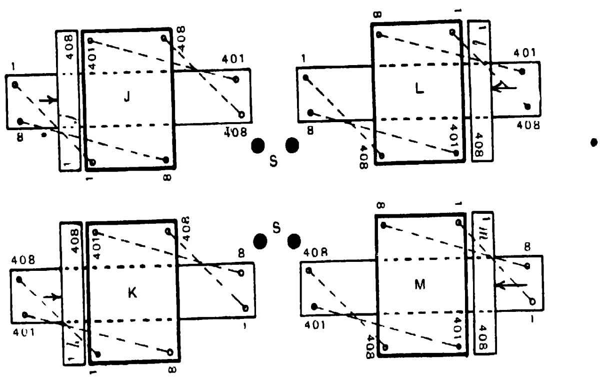


Fig. 192.

parts will appear identically with those at J in Fig. 192. Hence any set of cards which were used on cylinder *a*, Fig. 180, could be transferred to cylinder *j*, Fig. 192, and the cloths produced in the two looms would be absolutely identical so far as the outline and weaves of the design were

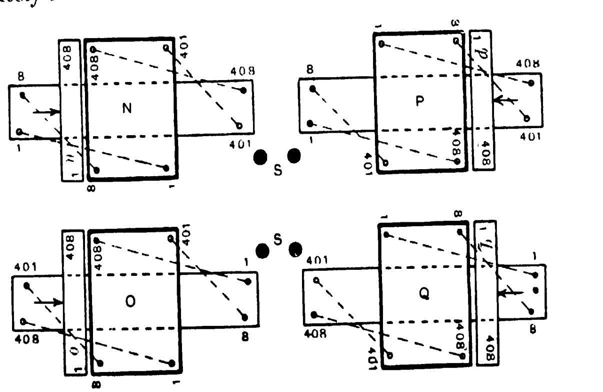


Fig. 193.

concerned. It will also be observed that in both diagrams the looms are right-hand ones, because the handle is on the right-hand side of the weaver. The two left-hand looms, B, Fig. 180, and K, Fig. 192, may be compared in the same way, and so may all the other machines represented by the vertical pairs in the above letters A to Q. The solid black circles S in

Figs. 192 and 193 represent, as in Figs. 180 and 181, the positions of the set-on or control handles, and it will be seen that in the three figures all positions are illustrated.

We have now explained at length the conditions regarding the relation between the first thread of the cloth and the so-called leading hook and needle of the jacquard for all positions of the jacquard with respect to the comberboard or harness-reed, and for the two distinct methods of drawing in the warp threads through the mails of the harness. In regard to the draft of the harness, we have assumed the simplest of all cases—*i.e.* that in which the number of hooks in the jacquard is exactly the same as the number of threads in the warp. Modifications of drafting have to be introduced for certain kinds of fabrics, but this branch of the subject has already been considered.

When the jacquard is placed above the loom so that the long rows of hooks are parallel to the short rows of the comberboard or harness-reed—*i.e.* for the London or crossed tie—the cards must obviously be near one end of the loom, as demonstrated in Figs. 192 and 193. The pulleys for one row of looms, right and left hand, are all in one row, and it is a common and almost invariable practice to have all the different sets of cards for one row of looms on one side, usually nearest the pass, *i.e.* furthest removed from the set-on positions S; occasionally, however, the cards are on the driving side. If the cards are at the opposite end to the driving end, it follows that in a right-hand loom the cards of the jacquard will be on the left-hand side of the loom and of the weaver, whereas in a left-hand loom the cards will be on the right-hand side of the loom and the weaver. Under such conditions it will be found that the connection between the hooks and threads in a right-hand loom, arranged for the London tie, corresponds with that in a loom arranged for the Norwich tie, where the cards are over the warp at the back of the loom. And naturally the conditions for a left-hand loom, London tie, correspond with those of a loom with the Norwich tie and the cards over the weaver's head. The remarks on page 18, however, in connection with London ties, should be kept in mind.

CHAPTER XIII

MECHANICAL METHODS OF LACING AND STITCHING CARDS

THERE are two distinct methods employed for this important work:

1. Where two sets of cords or lacing twine, single or double, are interlocked to hold the cards more or less securely between them.
2. Where two sets of tapes, one set under the cards and the other set over the cards, are secured to the cards by a system of sewing or stitching.

The order in which these machines are taken in this work does not necessarily indicate a difference in the respective merits of the various machines, but is adopted solely to suit the requirements of the author. Each well-known machine is extensively employed, and all are capable of producing satisfactorily laced cards.

The main requirements of mechanical lacers are—

1. An automatic or semi-automatic feeder or method of carrying the cards to the lacing mechanism, and of delivering them after they are laced.
2. Lock-stitch mechanism, if ordinary needles are used, and in all other cases if possible.
3. Thread take-up mechanism to reduce the stress to a minimum, and still to impart the necessary degree of tension to the lacing twines.
4. Provision for all the required rows of lacing to be performed simultaneously.

The modern card-lacing machine as made by the Singer Manufacturing Company Limited will be described and illustrated first, but before describing the complete machine we purpose introducing a few of the chief parts by means of which the above desirable and requisite functions are performed.

Three positive box cams, all secured to the main shaft of the machine, are employed for this purpose; they are—

A, Fig. 194, for operating the needles and the thread take-up levers.
B, Fig. 195, for operating the shuttle carriers and the shuttles.
C, Fig. 196, for operating the card feed wheels.

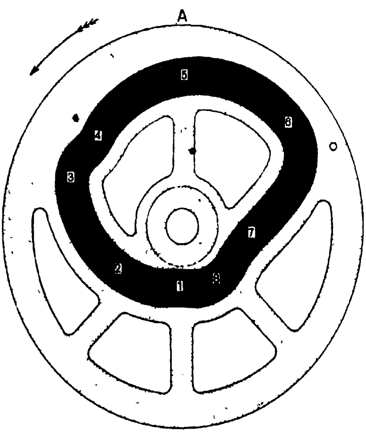


Fig. 194

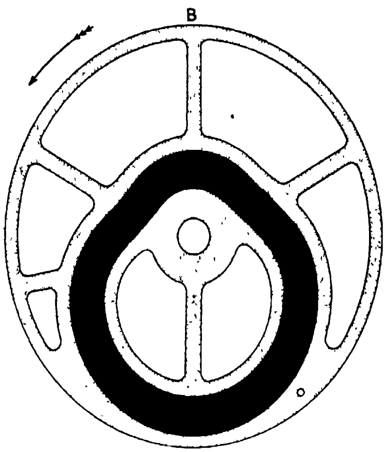


Fig. 195.

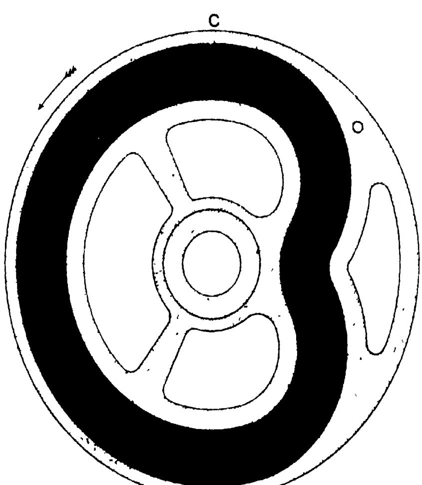


Fig. 196.

These three cams are essential whether the machine is driven by power or by foot, and the positions which they occupy are indicated in Figs.

197 and 198, as well as in subsequent illustrations. The main shaft D extends the full length of the machine, and when the machine is arranged to be driven by power the main shaft carries the loose and fast pulleys E and F, as shown in Fig. 197. This is a perspective view of the front of a 5-head machine, while Fig. 198 is a similar view of a 4-head machine intended to be driven by foot-power, and which requires one pulley only—the fast one.

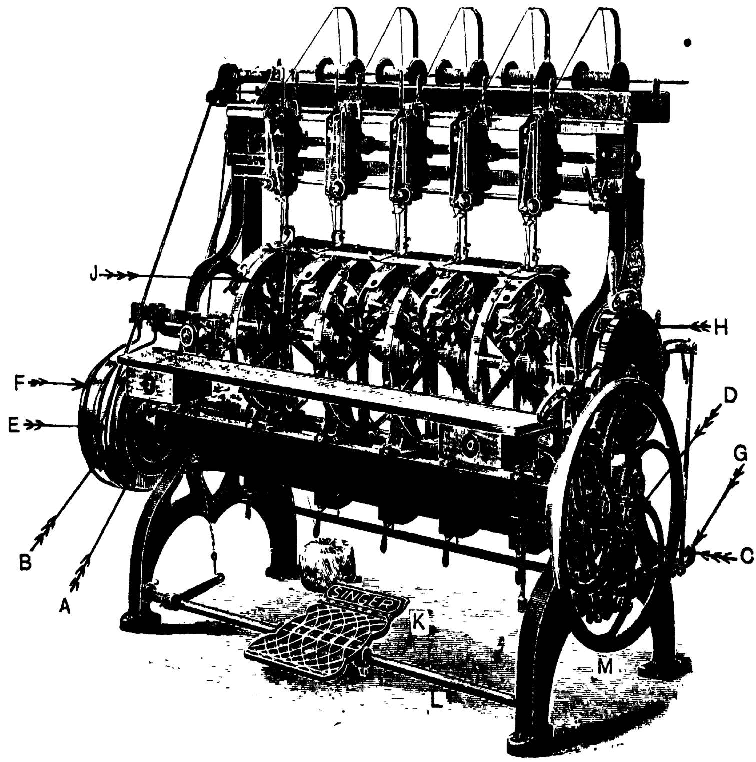


FIG. 197.

Fig. 198 shows clearly the cam C which actuates the three-armed lever G, shown separately in Fig. 199. The lever G, by means of connecting-rods and pushing pawls, drives the feed ratchet wheel H, and hence the feed-wheels J and J^1. The arrangement for driving the machine by foot-power is shown in Fig. 198. The treadle K on shaft L must obviously be operated by the attendant, and the oscillations imparted thereto are made to drive the balance and hand wheel M through the lever N, the

connecting arm O and a suitable crank on the end of the shaft P. On the opposite end of the shaft P is a pulley Q from which the main shaft D is driven by the belt R.

In power-driven machines the balance and hand wheel M is placed on the main shaft D, as shown in Fig. 197. In machines which are built specially and solely for power work it is a usual practice to dispense with the shaft P and the pulley Q, Fig. 198, and in the subsequent line drawings, as well as in Fig. 197, these parts are omitted.

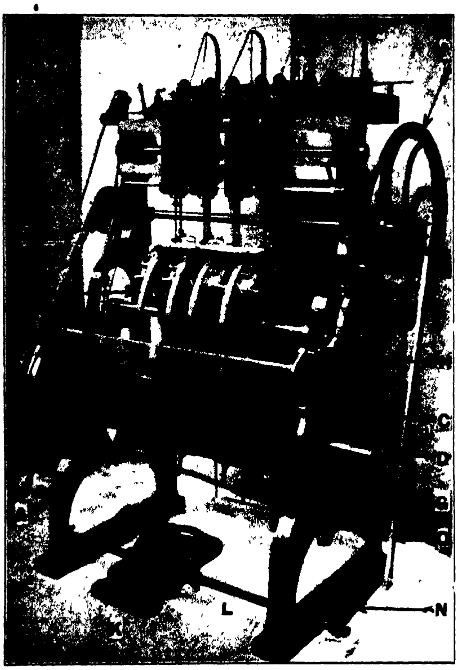


FIG. 198.

The speed of the machine depends chiefly upon the dexterity of the attendant, for since the feed-wheels J and J^1 move intermittently on the shaft D, which moves at a constant speed, it is evident that a card must always be in position to be drawn forward under the needles, otherwise a gap would result and the machine would have to be stopped. A good speed for this class of machine is 60 to 70 revs. per min. of the main shaft D, and, of course, of each of the cams A, B, and C, Figs. 194 to 196, which rotate with it.

Perhaps the most satisfactory way of describing the machine will be to take the mechanism for each individual operation separately, and then to show how all the parts must move in unison with each other to produce correct work.

Complete views of the mechanism are displayed in Figs. 200 to 214. Fig. 200 is an elevation of the driving end; Fig. 201 is an elevation of the opposite end; Fig. 202 is a front elevation of a three-head machine—the type required for lacing jacquard cards for 400's and 600's machines of the ordinary pitch. The remaining figures refer more particularly to sectional views and to special parts.

The feed-wheels J and J^1 are made in halves, as illustrated in the special view in Fig. 203; each pair is fixed together by set-screws as shown on the feed-shaft S. A box-key, shown suspended from two screw-nails in Fig. 202, is provided for this purpose, since it is sometimes necessary to change the positions of the wheels on the shafts, and at other times it is necessary to remove the set of wheels for the purpose of introducing another set to lace cards of a different width.

The two outer feed-wheels J, Fig. 203, are provided with a number of pegs or studs T which pass through the peg holes—one at each end of the card—in the usual manner; if there are intermediate peg holes, as is sometimes the case in long cards, an intermediate peg wheel is used with similar pegs fixed at the proper position on the shaft. In general, there are the same number of peg feed-wheels as there are peg holes in the length of the card. The total number of feed-wheels, however, is determined by the number of rows of lacing, and from what has been already said about this subject it is clear that for 8-row 400's and 12-row 600's jacquard cards of the ordinary pitch there are three sets of lacing twines; hence, for such cards, a third feed-wheel, the middle one marked J^1 in Figs. 202 and 203, is provided for the centre line of lacing. It is obvious, however, that pegs must not be inserted in the middle wheel J^1, since there are no corresponding peg holes in the card. This feed-wheel, however, is provided with thin metal projections T^1, Fig. 203, which are fixed on the periphery of the feed-wheel J^1 in such a way that each one is midway between the pegs T on the periphery of the feed-wheels J; thus the cards 26 lie between these thin metal projections, while the peg holes on the cards fit on the pegs T. The arrangement is clearly shown in the figure where the end bits of two cards are on the pegs T of the feed-wheel J on the left, and the middle bits of the same two cards are between the thin metal projections T^1 on the feed-wheel J^1 on the right.

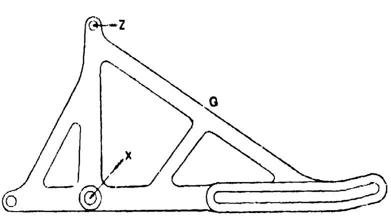


FIG. 199.

The distance between each pair of pegs T and each pair of projections T^1 obviously depends upon the width of the card. If there are two peg holes in each end of the card it is unnecessary to introduce a peg for each hole; one is quite sufficient at a place to carry the cards forward. The circumference of the feed-wheels for all widths of cards is practically the same, differing only by a fraction of an inch. and hence the number of pegs in the circumference of the feed-wheel is practically inversely

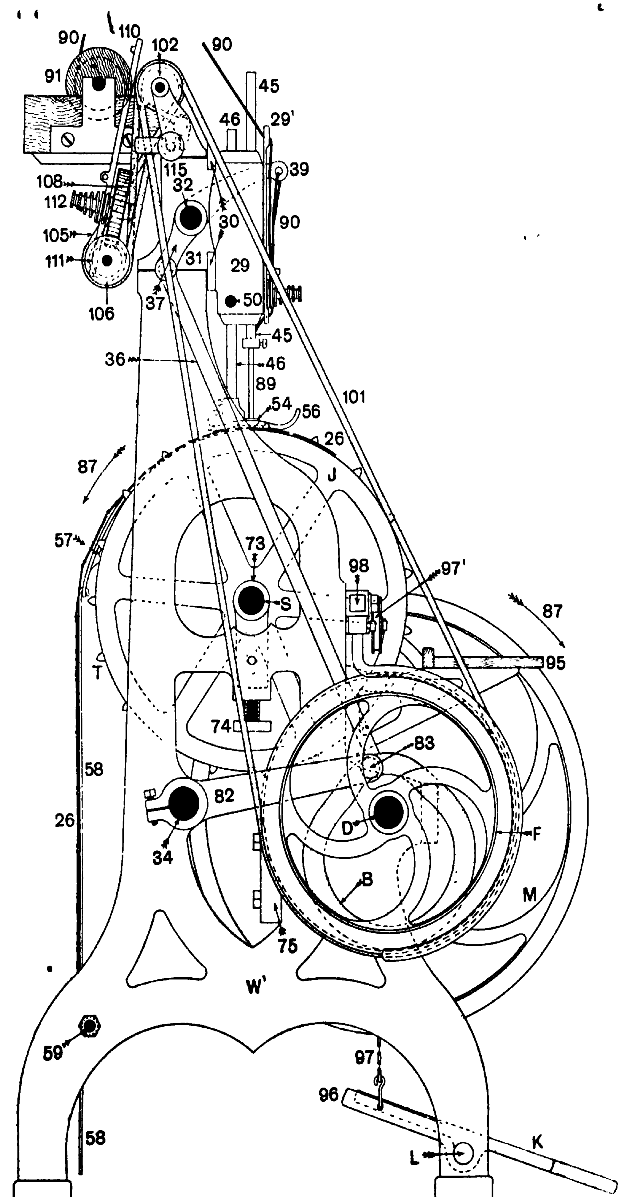

90
110
102
90
91
45
46
29'
39
108
115
32
112
30
90
105
31
29
111
37
50
106
45
36
46
89
101
54
56
26
87
J
57
73
98
97'
S
87
95
T
74
83
58
82
26
D
F
34
B
M
75
W'
59
97
96
K
L
58

FIG. 200.

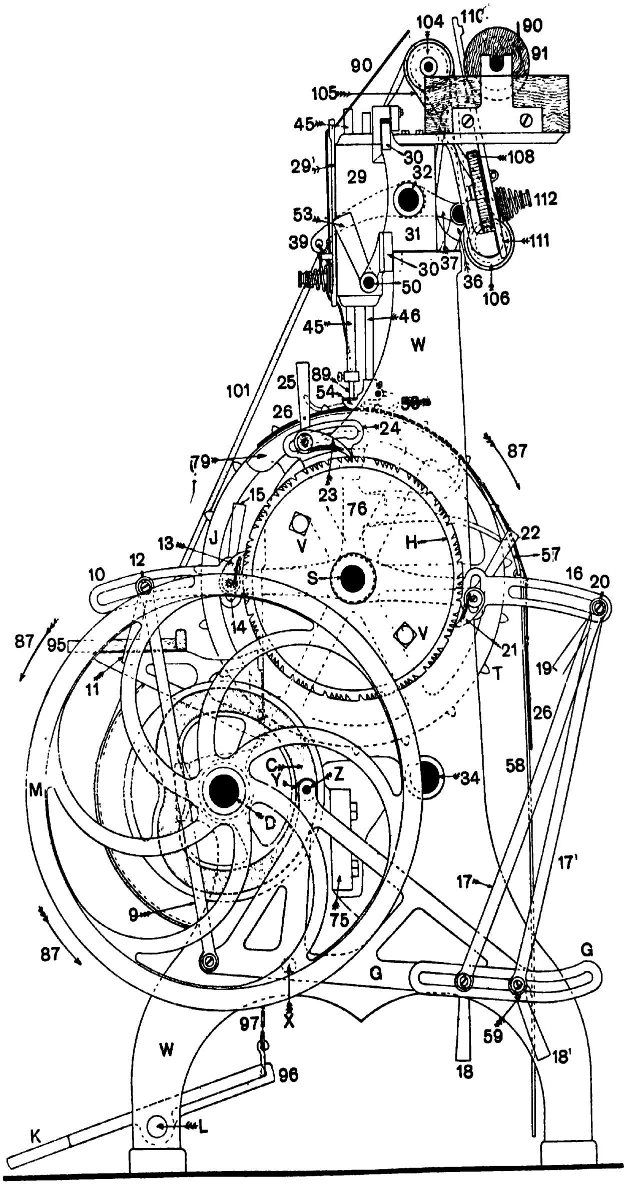

104
110
90
91
90
105
45
29'
29
30
32
108
112
53
31
39
111
30
37
50
36
106
45
46
W
89
25
54
101
56
26
24
87
79
23
76
15
22
J
H
57
13
V
12
S
16
20
10
14
21
87
95
V
19
T
11
26
58
C
Z
Y
34
M
D
17'
17
9
75
87
G
G
97
X
59
W
18'
18
96
K
L

FIG 201.

proportional to the width of the card. The actual numbers for three common types are as under:

For 8-row ordinary pitch cards (400's) there are 21 pegs;
For 12-row ordinary pitch cards (600's) there are 15 pegs;
For 8-row Brussels-carpet jacquard there are 19 pegs;

and so on for the other less-widely used machines.

Fixed near the end of the feed-shaft S, Fig. 202, is the feed ratchet carrier disc U, and to this disc is fixed the feed ratchet wheel H by means of set-screws V, Fig. 201. The feed-wheels J and J^1 as a body and the feed ratchet wheel H must obviously move forward intermittently through distances which are equal to the gaps between the holes on the cards themselves and the gaps between the outside holes of the cards and the opening between each pair of cards. These distances vary in different cards, and are not all the same on any card; hence the movement of the feed-wheels J and J^1 is of rather a complicated character. When, however, the correct distance has been fixed, the various movements are very accurate, and there is little or no danger of any faulty distances. It will be understood,

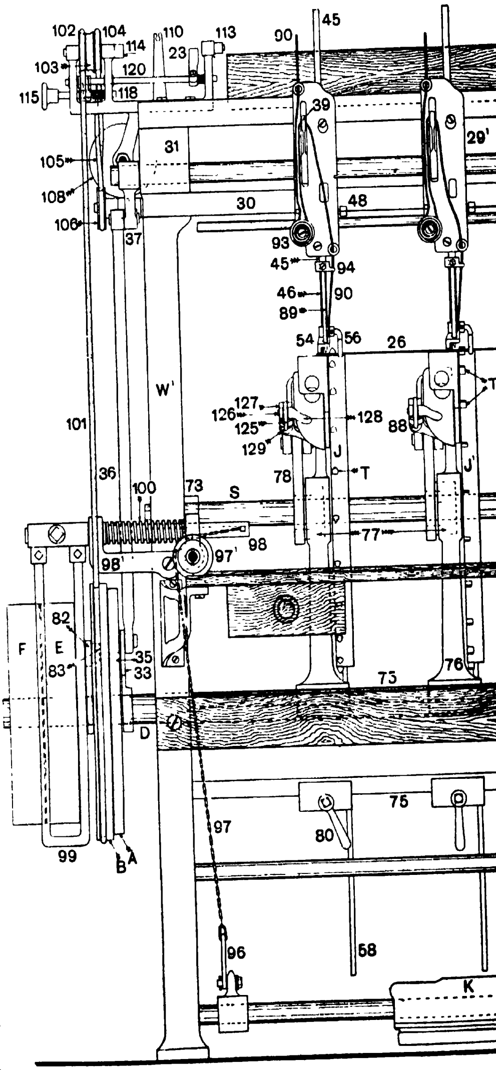


FIG. 202.

of course, that the movement of the feed-wheels takes place only when the needles are above the card.

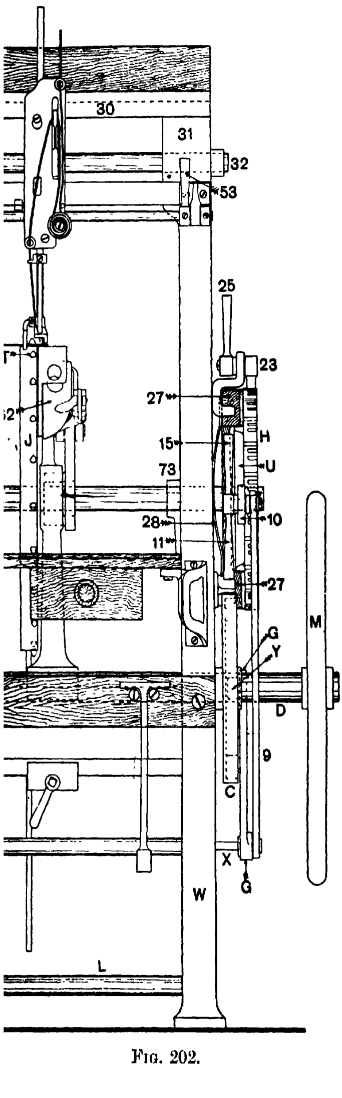


Fig. 202.

To simplify the description as much as possible, we shall assume in all cases, when considering the movements of the cams, that the observer is at that end of the machine illustrated in Fig. 201. In this view the feed rachet wheel cam C is between the frame W and the balance-wheel M (see also Fig. 202), while the three-armed lever G, fulcrumed on a stud X in the frame W, is between the cam C and the balance-wheel M.

The vertical arm of the three-armed lever G carries an anti-friction roller Y, supported on a pin Z, and hence capable of rotating freely in the groove of the cam C. A connecting-rod 9, Figs. 201 and 202, joins the short arm of lever G to the pawl lever 10, and is fixed in the proper position in the concentric slot of pawl lever 10 by the handle 11, while a small projecting pin or pointer 12 serves to locate the proper position with respect to marked places on the upper surface of the pawl lever 10. This lever is fulcrumed loosely on the feed-shaft S, Fig. 201, and its pawl 13 is fixed in the vertical slot 14 of the pawl lever 10 by means of the handle 15. In the slot of the long arm of lever G, and in the slot of another pawl lever 16, Fig. 201, is fixed a connecting-rod 17 by handles 18 and 19, while a similar indicator 20 is provided in the upper end of the connecting-rod 17. Similarly, the pawl lever 16 is fulcrumed loosely on the feed-shaft S, and is provided with an adjustable pawl 21 and fixing handle 22. Finally, a retaining catch 23 is adjustably fixed in the slot of the bracket 24 by handle 25. Each pawl 13, 21, and 23 is provided with a light spring as shown, which tends to keep the point of the pawl in close contact with the feed ratchet wheel H.

The positions of the various parts in Fig. 201 and the type of feed ratchet wheel illustrated there, and in the complete view in Fig. 204, are those which are necessary for the 8-row Brussels carpet jacquard cards. When the same lacing machine is intended to be employed for lacing different sizes of cards it is necessary to have, as already indicated, suitable feed-wheels J and J^1 for each set, as well as a differently cut feed ratchet wheel H to give the correct movements to the group of feed-wheels. In addition, it is necessary to move the upper end of connecting-rod 9 to the proper position in the slot of the pawl lever 10, and to move both ends of the connecting-rod 17 in the slots of levers G and 16. It is obviously impossible to show all the positions, but in Fig. 201 the lower end of the rod 17 has been moved as indicated by 17^1 and the handle 18^1 to the approximate position which would obtain when the machine was arranged to lace cards for an ordinary 8-row 400's jacquard.

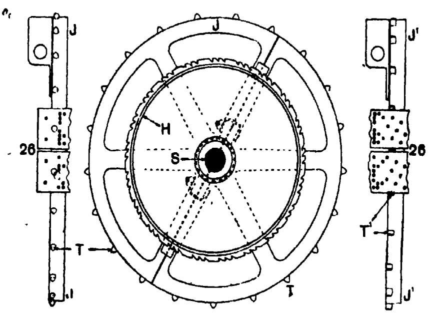


Fig. 203.

If the reader refers to the Brussels-carpet jacquard card illustrated in Fig. 99, he will see that on each card, and in every short row for lacing, there are four holes. These holes, with the gap between each pair of cards, make it essential that each lacing needle shall pass down and up five times each way for each card. Hence the sequence of the teeth in the feed ratchet wheel H is five, as is shown clearly by the Roman numerals on the elevation and plan of a section of the feed ratchet wheel, lettered H in Fig. 204. It will also be observed that one tooth only in each set, that marked III., is cut right across the face of the wheel—the others extend only partially across, and hence leave perfect concentric sections between each pair of fully-cut teeth III. The similar elevation and plans of sections of feed ratchet wheels lettered H^1, and the elevation H^{11}, repre-

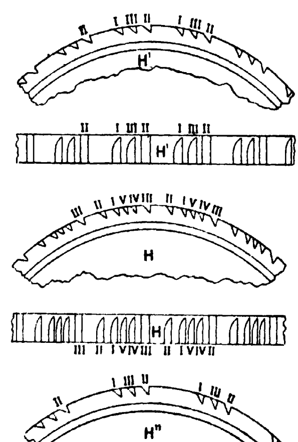


Fig. 204.

sent those which are used respectively for 400's and 600's cards, and for similar pitch 8-row and 12-row cards of different lengths. In both of these wheels there are two partially-cut teeth and one fully-cut tooth in each sequence, because in these cards there are only two lacing holes in the short row of cards and the usual gap between each pair of cards. In the five movements indicated by Roman numerals for the Brussels-carpet jacquard card, the middle number III. is for the comparatively long movement in the middle of the short rows on the card. In the 400's and 600's cards the three movements are represented by three Roman numerals and the middle number II. is that for the long stitch on the card.

To return to Fig. 201. It should be mentioned at once that the right-hand pawl 21 extends across the full width of the face of the feed ratchet wheel H, and can thus enter only into that tooth, or rather the recess III., which is fully cut. Moreover, it is this pawl which imparts the greatest movement to the feed ratchet wheel H, and hence to the feed-wheels J and J^1 and the card 26. The cards in Fig. 203 have been made with two lacing holes only in the width: this has been done for the sake of showing up the lacing rows distinctly; and although the feed ratchet wheel is for the Brussels-carpet jacquard cards, these sections of cards may be looked upon as being for a 400's jacquard machine of the ordinary pitch. The big movement for such a card, and the still bigger movement for the corresponding place in a 600's card, are both obviously greater than the corresponding movement required for the central portion of the Brussels-carpet card; this is easily seen by comparing the gaps immediately to the right of the recesses numbered III. and II. in the sections lettered H, H^1, and H^{11} in Fig. 204.

Without referring particularly to the movements of the needle, it will be seen that in Fig. 201 it is near its lowest position, and consequently no movement of the feed ratchet wheel H or the feed-wheels J and J^1 is possible. As a matter of fact, the needle is down below the card for a comparatively long period, so that the feed ratchet wheel H and the feed-wheels J and J^1 are kept stationary for this period by that part of the cam C, Fig. 196, which forms part of a true circle for approximately half a revolution. The anti-friction roller Y, Fig. 201, is therefore on its extreme right; whereas, when the cam C has rotated to the position indicated in Fig. 196, the bowl Y will be in the extreme left position—*i.e.* nearer the shaft D, Fig. 201—and the long and short arms of the three-armed lever G will thus have carried their respective pawl levers 10 and 16 to their lowest and highest positions ready for one or other of the pawls 13 and 21 to act on the feed ratchet wheel H. In Fig. 201 these arms have already acted, and are in their highest and lowest positions. The shaft D rotates counter-clockwise, as viewed from Fig. 201; hence, as the

anti-friction roller Y is approaching the shaft D the pawls 13 and 21 are moving to the active position, whereas when the anti-friction roller Y is moving towards the periphery of the cam C one of the pawls 13 or 21 is pushing the feed ratchet wheel clockwise through the distance required, such distance being determined by the particular part of the card which had been immediately under the needles.

Any position in the revolution of the main shaft D could naturally be selected as a starting point to describe the complete action; the one which we have taken is that represented in Fig. 201, where the needle is at present down between two cards of the Brussels type, or at that point lettered A in Fig. 205. The four holes in the card are lettered B, C, D, and E to the left, because these letters will appear in their proper alphabetical order as the card moves to the right. A further enlarged view of part of the face of the feed ratchet wheel H is also reproduced in this figure, but not to the same scale as the cards. The various sections for one round, or rather cycle, necessary for the movements for the lacing of one card are marked by Roman numerals, I., II., III., IV., and V., as before, and also, in addition, by small letters between the numerals. Since the movements of the shuttle, and also the needles, will be required shortly, we introduce the following table, which shows the extreme positions of both, as well as the positions of the pawls 13, 21, and 23, for each complete revolution of the main shaft D, Fig. 201:

TABLE VI.

Letters on and between the Card 26.	Position of Needle.	Position of Shuttle.	Position of Left Pawl 13 on Wheel H.	Position of Top Pawl 21 on Wheel H.	Position of Right Pawl 23 on Wheel H.
A	Down	Back	V.	V.	*b.*
A	Up	Front	I.	V	*e.*
B	Down	Back	I.	I.	*a.*
B	Up	Front	II.	I.	*d.*
C	Down	Back	II.	II.	*e.*
C	Up	Front	*d.*	II.	III.
D	Down	Back	III.	III	III.
D	Up	Front	IV.	III.	V.
E	Down	Back	IV.	IV.	*e.*
E	Up	Front	V	IV.	*a.*

In all cases, for this wheel and for any other, the right pawl 21 operates only on the feed ratchet wheel when it can enter the fully-cut recess marked III. in H and II. in H^1 and H^{11}, Fig. 204; while since both pawls 13 and 21 move simultaneously, it follows that the left pawl 13 will, at this time, be ineffective on the broad part *d*, Fig. 205, between II. and III. The arrows from the various parts of the upper lacing twine in Fig. 205 to the recesses in the section of the feed ratchet wheel H show which tooth or

recess is acted upon for the length of twine between the letters. Pawl 13 acts on four of the short recesses, and pawl 21 on the fifth.

The movements of the feed ratchet wheel H for the 400's and 600's cards are much simpler than the above. In general, when these cards for 400's and 600's machines are being laced, and when pawls 13 and 21 are just ready to push the feed ratchet wheel, one or other of the pushing pawls will be in touch with a recess, but the one which for the moment is not in contact with a recess, or which is unable to enter a recess, is marked 0 in the following table to indicate that it can have no effect at this particular time. The Roman numerals show which recesses the various pawls are in contact with (refer to H^1 and H^{11}, Fig. 204):

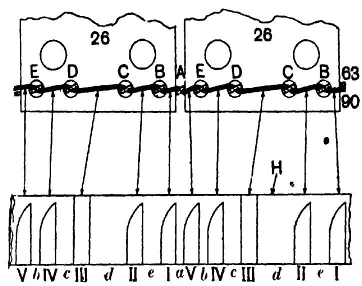


Fig. 205.

TABLE VII.

Pawl 13	III.	I.	0.	III.	I.	0.	III.	I.	0.
Pawl 21	0.	0.	II.	0.	0.	II.	0.	0.	II.
Pawl 23	III.	I.	II.	III,	I.	II.	III.	I.	II.

From the lengths of the left and right arms of lever G, Figs. 199 and 201, it is obvious that the movement of pawl 13 will always be much less than the movement of pawl 21. It will also be quite clear that if all the distances between the holes on the cards, and between the outside holes and the gap between each pair of cards, were exactly the same, one pushing pawl only would be necessary, and arranged to operate a uniformly-cut feed ratchet wheel. The movements of the feed ratchet wheel H are limited to the correct distances by the pawls 13 and 21, and by the aid of a leather-faced wooden brake 27 and spring 28, Fig. 202. A small projection on the feed-shaft bracket 73 is provided with a set-screw by means of which the tension on the spring 28 may be adjusted.

NEEDLES AND THREAD TAKE-UP MECHANISM.—A separate head is required for each row of lacing; side elevations of these heads are numbered 29 and front covers 29^1 in Figs. 200 and 201, while complete views of the fronts of three heads are illustrated in Fig. 202. All the heads for one machine are supported by the two planed surfaces 30 of the upper cross-rail 31, and the needle bar rock shaft 32 passes behind all as shown.

Fulcrumed loosely on the shaft 34, Figs. 202, 209, and 210, is one end of a

lever 33; its opposite and free end carries an anti-friction roller 35, which runs in the groove of the box cam A. A connecting-rod 36 joins the free end of lever 33 to the crank 37 on the end of the needle bar rock shaft 32; hence, as the main shaft D revolves, the undulating outline of the positive cam A will impart a diverse series of oscillations to the needle bar rock shaft 32 and to all parts which are connected to it. In general, it will be gathered from the parts illustrated that as the anti-friction roller 35 moves downwards towards the centre of its disc 38, Figs. 209 and 210, the connecting-rod 36 will fall and cause the needle bar rock shaft 32 to move clockwise in Figs. 209, 210, and 201, and counter-clockwise in Fig. 200. In all cases, however, all subsequent attachments to the needle bar rock shaft 32 move upwards when the anti-friction roller 35 moves downwards. Conversely, when the roller 35 moves upwards towards the periphery of its disc 38, the connecting-rod 36 rises and all parts in the head 29 fall. No further explanation of these parts is desirable at present, since the actual movements will be better explained in conjunction with the movements of the shuttle. It is necessary, however, to examine the connections between the needle bar rock shaft 32 and the various parts which are partially or wholly enclosed in the head 29. For this purpose Figs. 206 and 207 have been prepared; the former is a side elevation of the head, and the latter is a front elevation of the same—in both figures the front cover 29^1, Fig. 202, has been omitted.

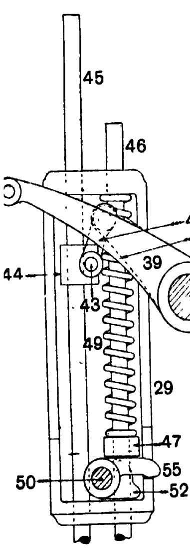


Fig. 206.

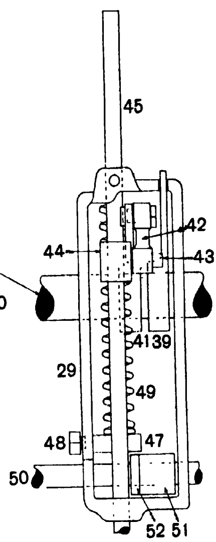


Fig. 207.

On the needle bar rock shaft 32, and immediately behind each head, is fixed a thread take-up lever 39 by means of a wing-bolt 40, so that each take-up lever may be adjusted independently of any other to suit the degree of movement required at the extreme end of the lever. The lacing twine 90 passes through the hole in the end of the take-up lever 39, as exemplified in Figs. 200, 201, 202, 209, and 210. Each lever 39 moves in

opposite directions to, and reciprocally with, the crank 37 in the above five figures. Fixed near to each take-up lever 39, also on the needle bar rock shaft 32, by a set-screw, is a needle bar rock shaft crank 41, Figs. 206 and 207. Attached to the end of crank 41 is a link 42; the lower end of this link encircles a pin 43 which projects from the side of the collar 44. The latter is fixed by two set-screws to the needle bar 45. It will thus be seen that, as the needle bar rock shaft 32 oscillates, each needle bar 45 will rise and fall in unison with the similar movements of its companion thread take-up lever 39.

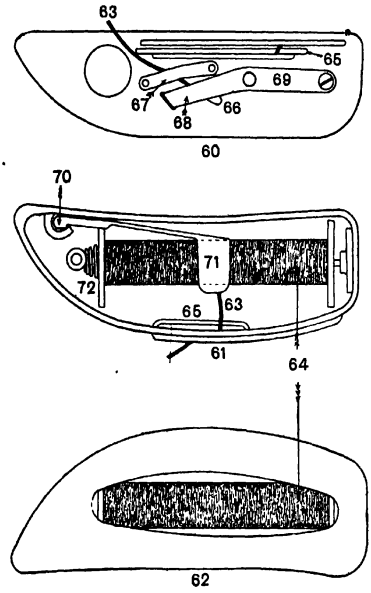


FIG. 208.

The presser foot bar 46 is immediately behind the needle bar 45; to the former, and near the bottom of the head 29, is fixed the bracket 47 by the set-screw 48. Between this bracket and the upper shell of the head 29 is a spiral spring 49 which encircles the presser foot bar 46. The presser bar rod 50 extends from the frame W, Fig. 202, through all the heads 29 as shown, while inside each head is a combined collar 51 and cam 52, Figs. 206 and 207, secured to the rod 50. Rod and cams are operated by the handle 53, Fig. 202. Thus, when the handle 53, Figs. 201 and 202, is pressed downwards, the cam 52, Figs. 206 and 207, rotates slightly and raises the bracket 47, compresses the spiral spring 49, and a recess in the cam serves to hold the bracket 47 and the presser foot bar up with the presser foot 54 clear of the cards 26. Immediately, however, the handle 53 is raised, the cam 52 is lowered until the projecting piece 55 comes into contact with the bottom of the slot in the back shell of 29; while the cam 52 is being thus rotated, the pressure of the spiral spring 49 on the bracket 47 forces the latter and the presser foot downwards until the presser foot 54 reaches the card 26.

Attached to each presser foot 54, Figs. 200, 201, 202, 209, and 210, by a small set-screw, is a curved card wire guide 56. These card guides ensure that the cards shall be guided safely under each presser foot 54.

When the laced cards reach the back of the feed-wheels J and J^1, Figs. 200 and 201, they are effectively removed from the pegs T and T^1 by the card lifters 57, to be ultimately guided safely to the floor or on to a suitable stand by the thin wire guides 58 which bear against the stay rod 59.

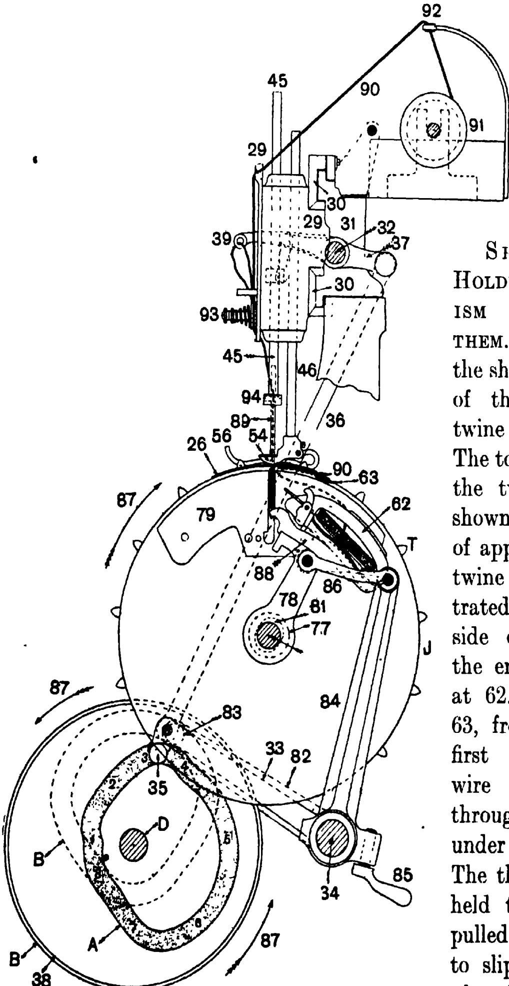


FIG. 209.

SHUTTLES, SHUTTLE HOLDERS, AND MECHANISM FOR OSCILLATING THEM. — Three views of the shuttle and the method of threading the lacing twine appear in Fig. 208. The top of the shuttle with the twine in position is shown at 60; the method of applying tension to the twine and spool is illustrated at 61; while the side of the shuttle and the enclosed spool appear at 62. The lacing twine 63, from the spool 64, is first passed behind the wire 65, then threaded through the hole 66 and under the flat plate 67. The thread on the spool is held taut and the twine pulled to enable the latter to slip under the end 68 of spring 69 into the position indicated in view 60. A small spiral spring is enclosed under the end 70 of the spool brake 71, and this spring causes the flat end to exert the necessary amount of tension. A spiral spring 72 also aids in this by its pressure against the flange of the spool 64.

The travel of the shuttle carrier is constant so far as distance is concerned, and the distance between the carrier when it is vertical and the presser foot 54 must also be constant, no matter what set of feed-wheels are in use, in order to preserve the correct relation between the needles and the shuttles. It has already been mentioned that there is a slight difference between the diameters of the various sets of feed-wheels J and J^1, and hence it is necessary to provide means for raising and lowering the set without interfering with the mechanism which governs the movements of the shuttle carriers.

All the feed-wheels J and J^1, for one set, are, as previously mentioned, on the feed-wheel shaft S, Fig. 202, and the oscillating shuttle carrier also works upon this shaft as a centre, or rather as an approximate centre. The feed-wheel shaft S is supported by two brackets 73, one on frame W and the other on frame W^1, Figs. 200 and 202. These brackets 73 can be raised or lowered, within the required limits, by the milled-head screws 74; and when the two brackets and the shaft S have been adjusted correctly to place the feed-wheels J and J^1 at their correct height with respect to the shuttle carriers and needles, the brackets 73 are securely fixed to the frames W and W^1 by set-screws.

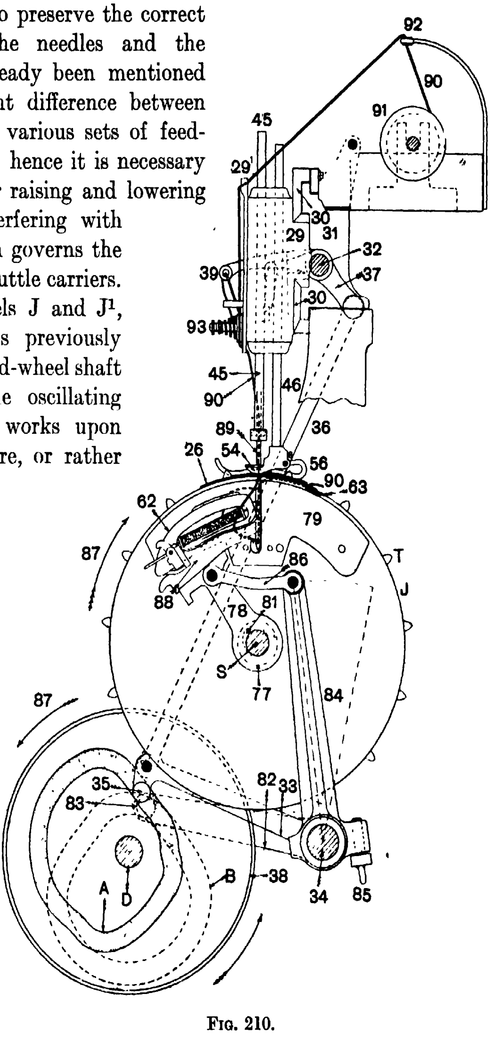


FIG. 210.

Secured to one of the main cross-rails 75, Figs. 200, 201, and 202,

are two, three, or more upright brackets 76, shown only in Fig. 202. The boss near the upper end of each of these brackets is bored out to receive the projecting boss 77 of the vibrating lever 78, while the bracket 76 is prolonged above the boss to provide supports for the shuttle face-plate 79—seen best in Figs. 209 and 210—and for the card lifters 57, Fig. 201. It is, of course, understood that the brackets 76 are capable of being slid along the planed bearings of the cross-rail 75 and fixed at any place by the hand-screws 80. The brackets and the shuttle carriers can thus be placed in their correct positions with regard to the rows of lacing, and the heads 29 can be moved in a similar way along the planed surfaces 30, and fixed by similar hand-screws not shown in the drawings but clearly visible above the heads 29 in Figs. 197 and 198.

Although the boss 77, Figs. 209 and 210, of the vibrating lever 78 is turned down to fit the hole in the boss of bracket 76, the hole 81 in the boss 77 is not circular, but is lengthened into a kind of ellipse, as shown. Hence the boss of bracket 76 is capable of keeping the boss 77 of the vibrating lever 78 in one fixed horizontal frame, while the feed-wheel shaft S can be raised or lowered through the necessary distance in virtue of the elliptical hole 81.

The shuttle carrier is operated as follows from the cam B, Figs. 200, 209, and 210. A lever 82 is fixed to the shaft 34, and an anti-friction roller 83 fits neatly into the groove of the positive cam B as shown. Along the shaft 34, and at the proper intervals, appear a number of shuttle rock-shaft levers 84, each of which is secured to the shaft 34 by the hand-screws 85, shown only in Figs. 209 and 210. The upper end of each of these levers 84 is joined to the corresponding upper end of vibrating lever 78 by a link 86. Hence it is evident that, as the parts revolve in the direction of the arrows 87, the recessed cam B will cause the levers 82 and 84 to oscillate, and will cause the latter to move through the angle enclosed by the dotted lines in Fig. 210. In doing so, the links 86 and the vibrating levers 78 will be moved to right and left alternately. The shuttle carrier 88 is fixed to the upper part of the vibrating lever 78; consequently, the shuttle is carried twice between the two extremes for each revolution of the cam B and the main shaft D.

Fig. 209 illustrates the back position of the shuttle and shuttle carrier, and at this time the needle 89, which is fixed to the needle bar 45 in the usual way, is down as illustrated. The upper lacing twine 90, from the bobbin 91, is first passed through the eye 92 of the upper guide, then through the upper eye in the front head cover 29^1, behind the guide pin and between the plates of the tension device 93, Fig. 202, up again and through the eye of the thread take-up lever 39, then down and through an eye near the bottom of the front cover 29^1, and through the eye in the

needle bar stud 94, and finally through the eye of the needle 89. The eye of the needle takes the lacing twine to the position shown in Fig. 209, and here two lengths of twine extend from the eye of the needle to the cards; one length is shown in dotted lines behind the needle, while the other length is shown solid in front of the needle. At the particular time indicated in Fig. 209 these two lengths of twine are comparatively straight and taut; but it is obvious that a gap must be made between the outer or solid-marked length of lacing twine and the needle 89 in order that the tip of the shuttle 62 may enter between the two lengths, and so enable the upper lacing twine to be locked on the underside of the card by the spool twine 63 when the needle 89 rises to its highest point.

As already mentioned, the needle is controlled by the positive cam A, and it will be advisable to study the cam illustrated in Fig. 194 in conjunction with Figs. 209 and 210. When point 1 of the cam A is in touch with the anti-friction roller 35, the needle is up; at point 2 the needle is moving down, while between points 1 and 2 the shuttle reaches the back position —that shown in Fig. 209; at point 3 the needle is nearly in its lowest position. The needle moves down a little from this point, then rises slightly at point 4 to form the slack in the length marked solid in front of the needle, and immediately after this point the cam B causes the shuttle to commence its travel. From point 4 to point 5 the needle goes almost to its extreme low position to relieve the tension on the upper lacing twine, as the thick part of the shuttle is passing between the twine and the needle, and so requires a longer length to avoid unnecessary friction. At point 6 the needle is full down, and the shuttle has reached the other side. At point 7 the needle is rising from its lowest position, and when it is about ½ in. up it is drawing the lacing twine over the back of the shuttle as illustrated in Fig. 210. Finally, at 8 the needle is approaching the highest position.

To supplement the above description, and also to enable the reader to gather a better idea of the relative movements of the needle and shuttle, we append in Table VIII. particulars of the times for one complete revolution of shaft D, starting at a marked position of the balance-wheel when the needle is about ⅜ in. from its lowest position and the shuttle is in the back position.

TABLE VIII.

At 360° the needle is about ⅜ in. from the lowest position.

From 360° to 30° the needle is rising a little, say ⅛ in. to $\frac{3}{16}$ in., to form a loop on the lacing twine for the tip of the shuttle to enter.

At 30° the needle commences to go down.

„ 80° „ is full down.

„ 90° „ commences to rise.

At 180° the needle is nearly at the top.
„ 225° „ after a slight pause commences to move upwards again.
„ 240° „ reaches the highest position and almost immediately commences the return journey.
From 240° to 360° the needle is moving downwards to the first point of observation.
At 360° the shuttle commences to move from full back position.
„ 30° the shuttle tip is entering the loop between the needle and the lacing twine.
„ 90° the shuttle is midway in its travel.
„ 120° the shuttle is at the front.
„ 135° the lacing twine is slipping over the back of the shuttle.
„ 210° the shuttle commences to move back.
„ 330° the point of the shuttle is passing the plane of the needle.
„ 345° the shuttle is full back.
„ 360° first point of observation.

With respect to these degrees it should be stated that the feed ratchet wheel H commences to move at 195°.

It will be seen that the lacing twine 63 from the shuttle 62, Figs. 209 and 210, simply passes through the loop formed by the upper lacing twine 90; that when the needle is above the card the latter is taken forward by the feed-wheels J and J^1, and the shuttle reaches the back position. The lacing twine 63 under the card is shown in dotted lines, and it extends to the spool in the shuttle. After the shuttle and twine 63 have passed through the loop, the upper lacing twine 90 is drawn tight by the combined action of the needle 89 and the thread take-up lever 39, and hence the spool twine 63 prevents the loop of the upper twine 90 from being carried upwards beyond the underside of the card 26. When the shuttle is moved to the back position, and the card has been moved through one of the divisions, the lacing twine 63 is naturally again on the right, as illustrated in Fig. 209, and ready again to move forward at the proper time to intercept the upward moving loop of the upper lacing twine 90.

It will be understood that the thread take-up lever 39 plays an important part in the regulation of the tension on the lacing twine. It will also be seen that, since the thread take-up lever 39 and the needle bar lever 41, Fig. 206, move in unison with the needle bar rock shaft 32, the movements of the needle and the thread take-up lever will practically coincide, although the latter naturally moves through a greater distance than the former.

The operator sits in front of the machine, Fig. 202, with a pile of cut and numbered cards on the table 95, and, when all is ready for starting, she presses down the back part of treadle K, on shaft L, and this movement will clearly cause the lever 96, also fulcrumed on shaft L, to pull down the chain 97^1; the upper part of this chain 97^1 runs in the groove of a pulley 97, while the extreme end of the chain is attached to a stud in the belt fork shipper bracket 98^1. The belt fork 99 being fixed to the outer end of the sliding bar 98 of shipper bracket 98^1, it follows that the belt fork

will be moved outwards to carry the belt on to the fast pulley F, and the machine will then start. At the same time a small pin in the sliding bar 98 pushes the spiral spring 100 to the left and compresses it ready for it to exert its stored energy when required.

It is a usual plan to have a few old cards on the pegs T under and behind the needles to facilitate the starting, and to remove these cards subsequently. As the feed-wheels J and J^1 move slowly round, the attendant takes the cards, one by one, from the pile, and inserts them in successive order on the pins T. As long as she can feed the cards quick enough, and all the lacing twines 63 and 90 keep intact, the back part of the treadle K is kept down. If, however, a lacing twine breaks or runs off, or the pile of cards is used up, or any other condition should arise which demands the stoppage of the machine, she simply releases her foot pressure on the back part of treadle K, when the compressed spring 100 forces back its retaining pin and sliding bar 98, and thus places the belt fork in the off-position, as illustrated in Fig. 202.

In order that the operation of lacing may proceed almost continuously and with a maximum output, it is essential that all the lacing twines should be strong enough to withstand the stress, and that they should be free from knots and lumps to enable them to pass freely and easily through the eyes of the needles and the shuttles. Uneven twines are disastrous, for not only do they impede the work by breaking, but they also often cause the needles themselves to break. While strict economy should be practised in every department, and is absolutely essential to success, it is not always economical to use the cheapest twines for lacing, and particularly for machine lacing.

The lacing twine for the needles may come from balls such as the one shown on the floor in Fig. 197, but, preferably, the twine should be wound on to bobbins, and, during the winding process, should pass through a guide or an eye which will not allow a knot or a lump to pass. The lacing twine for the spools should be taken from the specially wound bobbins for the same reason.

The spools for the shuttles are $4\frac{1}{4}$ in. between the flanges, and the latter are about $1\frac{1}{2}$ in. diameter; the spools, therefore, hold a comparatively long length even of thick twine. The lacing twine is wound on to the spools by the unique mechanism illustrated generally in Figs. 200, 201, and 202, but more particularly in the detailed views of the chief parts in Figs. 211 to 214. Fig. 211 is an elevation from the front of the machine; Fig. 212 is a back elevation; Fig. 213 is a plan; while Fig. 214 is an enlarged view of part of the setting-on motion and part of the automatic stop motion. Referring to Figs. 200 to 202, it will be seen that on the periphery of the disc of cam B is a groove for the round driving belt 101.

This belt drives the outside and loose pulley 102 (see now also Figs. 211 to 214). Fig. 211 illustrates the belt 101 on the loose pulley, while Fig. 212 shows the same belt on the fast pulley 103. When the belt 101 is on the fast pulley 103, the inside pulley 104 is put in action, and the crossed belt 105 drives the lower pulley 106, together with its shaft and the worm 107. The worm-shaft is suitably supported by a projecting bracket from the main support of the winding apparatus. The worm 107 gears with and drives the worm-wheel 108 of about 120 teeth, while forming part of the wheel 108 is a heart cam 109, Fig. 212. A yarn guide 110, fulcrumed at 111, is provided with an anti-friction roller which runs freely in the heart cam 109, while on the opposite side of the yarn guide is a tension device 112, between the plates of which the lacing twine 63 passes before being carried to the guide itself in the upper part of 110. The direction followed by the lacing twine is clearly seen in the figures.

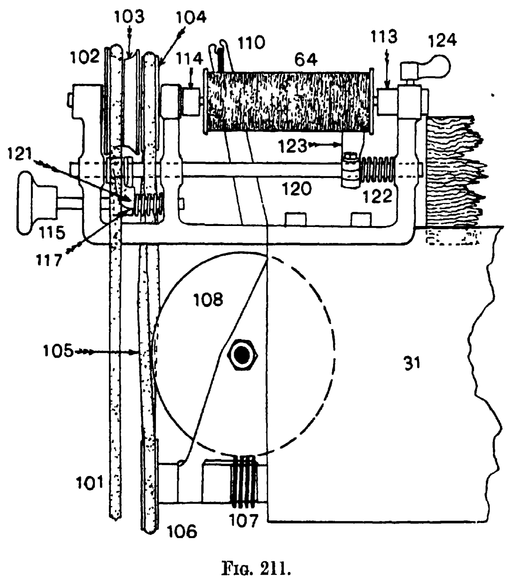


FIG. 211.

Since this apparatus is provided with an automatic stop-motion, the spools may be filled simultaneously with the lacing of the cards. Thus, suppose it is required to fill a few spools for the shuttles, an empty spool is placed between the holder 113 and the driver 114, Fig. 202, also plan view, Fig. 213, the twine wrapped round the shank or else caught in a slit in the spool, and the knob 115 pushed in. This action carries inwards a horizontal belt fork 116, Fig. 213, which places the belt 101 on the fast pulley 103, Fig. 212. At the same time the boss 117, Fig. 214, to which the belt fork 116 is attached, compresses the spring 118. The belt fork 116 is kept horizontal by means of a second fork 119, also forming part of the boss 117, the prongs of which are perpendicular to those of 117, and they are kept in this position in virtue of their relation to the rod 120—a prong appearing on each side of the rod. Fixed to the rod 120 is the

knock-off catch 121, and a projection on the inside of its lower arm slips behind the boss 117 in virtue of the action of the spring 122, Figs. 211 and 212, which always possesses the tendency to keep the knock-off catch in close contact with the boss 117, and also to keep the free end of the lever 123 hard in contact with the empty spool or with the yarn on the spool. It will be seen that the lever 123 is fixed to the rod 120, Fig. 211.

Now, with the various parts as illustrated, it follows that when the knob 115 is moved from the position illustrated in Figs. 211, 213, and 214, to that shown in Fig. 212, the belt 101 will, through the fast pulley 103, start all the spool-winding mechanism. As the heart cam 109 moves slowly round under the influence of the worm 107 and worm-wheel 108, the upper end of the yarn guide will carry the lacing twine from flange to flange of the spool and so distribute it gradually and evenly. This process will continue from the $\frac{1}{4}$ in. barrel through the various stages, including that of the half-filled spool in Fig. 212, and the subsequent ones, until the spool is filled as illustrated in Figs. 211 and 213. During the gradual filling of the spool, it follows that since one end of lever 123 is fixed to the rod 120, the other and free end will be forced downwards very slowly and in proportion to the increasing diameter of the spool and twine. It also follows that this action will cause the rod 120 to rotate slightly and extremely slowly, but still to move, and in doing so it will impart a proportionate movement to the knock-off lever 121, Fig. 214. This exceedingly slow movement continues until the catch at the back of the lower arm of the knock-off lever clears the periphery or flattened part of the boss 117. This is naturally timed to happen when the spool is full, and it is clear that when the connection between the boss 117 and the knock-off catch is broken the former will be forced to the left, that shown in Figs. 211, 213, and 214, through the action of the spring 118, and thus the belt fork 116 will carry the belt 101 to the loose pulley 102, and the

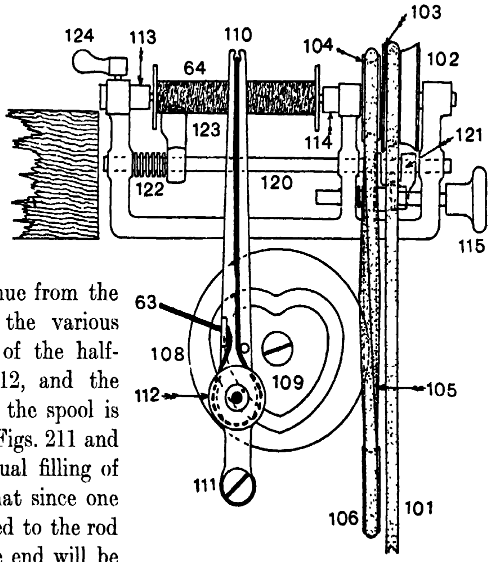


FIG. 212.

spool will remain motionless until the operator can remove it from its grips. The holder 113 is held in position and loosened when required by the hand-screw 124. The mechanism requires delicate setting, but when once properly fitted, it performs the winding and the automatic stopping elegantly and accurately.

When the lacing twine becomes exhausted in any of the spools in the

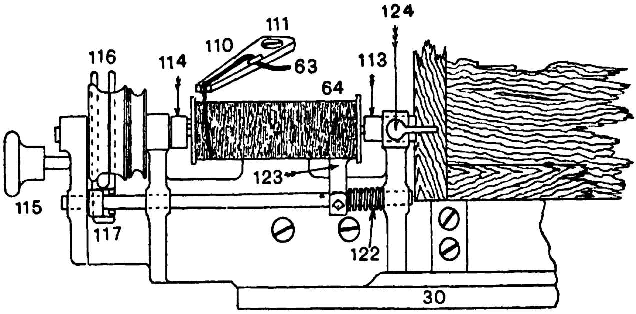


FIG. 213.

shuttles, the latter must be withdrawn from its carrier in order to introduce a full spool. The machine must obviously be stopped for this purpose, and turned by hand until the shuttle carriers are in the full forward position as indicated in Fig. 202. The longer arm of lever 125, fulcrumed at 126, is then depressed until the back and shorter arm is raised clear of the erections 127. The lever 125 as a whole, as well as the upper shuttle grip 128, can then be rotated about the stud 129 until the grip 128 is approximately vertical; when this has been done, the shuttle can be withdrawn from its carrier, and replaced again after it has been supplied with a full spool.

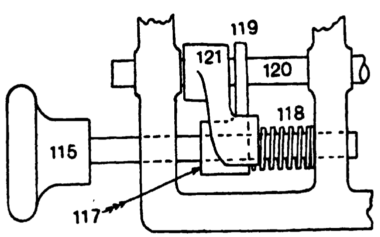


FIG. 214.

Another very successful card lacing machine is that known as Parkinson's "Rapid" machine, and now made by Messrs. John T. Hardaker, Ltd., Bradford. All lacing machines are provided with mechanism which moves the cards intermittently according to the space between the lace holes in the card and the distance between the centre of the gap between successive cards and the outside hole on the card. In this particular machine these essential movements are made by cams and a ratchet-wheel in conjunction with the necessary intermediate lever and two card carriers.

Thus, Fig. 215 illustrates the cams which are employed for the lacing of cards for Brussels-carpet looms, and for other cards of the same size in

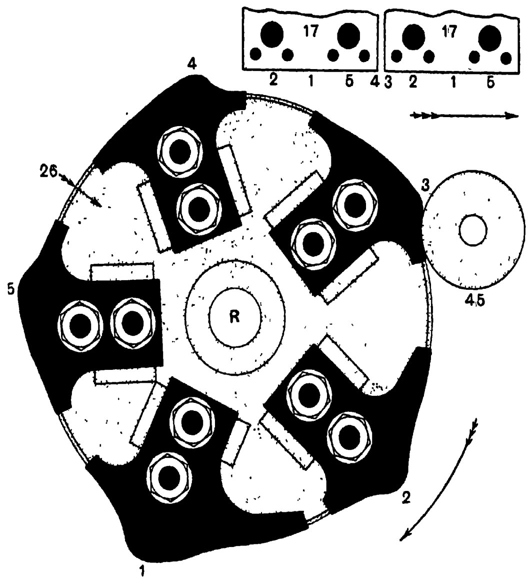


FIG. 215.

which four lace holes appear at each end of the card; while Fig. 216 shows the ratchet-wheel which is used in conjunction with these cams.

The five cams are shown in solid black in Fig. 215 and bolted to the disc 26, and slight variations in the throw of each cam are possible by sliding the cam between the pair of guides so as to place it nearer to or farther from the centre R. The ends of two cards for Brussels-carpet cards appear in the upper part of the drawing; both are numbered 17. During the lacing operation the cards move from left to right, as indicated by the straight arrow, while the disc 26 and the five cams move clockwise, as shown by the curved arrow. No. 3 cam is just going

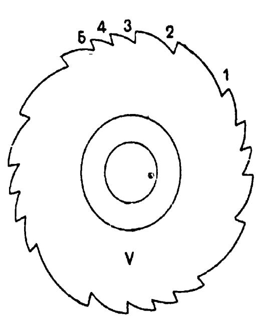


FIG. 216.

to act against the anti-friction bowl 45, and when the latter is forced outwards the intervening mechanism between it and the ratchet-wheel V, shown in Fig. 216, causes the ratchet to move clockwise from point 3

to point 4, and so on with each succeeding cam. Each cam in Fig. 215 is numbered to correspond with the similar numbers on the ratchet-wheel in Fig. 216, the cycle of movements, 1 to 5, causing the ratchet-wheel on the card chain shaft to move the card-carrier chains, and therefore the cards 17, through the distances indicated by the same numbers, 1 to 5, on the cards in Fig. 215. It will thus be seen that one complete revolution of the disc 26 and the cams is made for each card, but that the ratchet-wheel, Fig. 216, makes one revolution for four cards, since the group of five teeth for one card is repeated four times on the ratchet-wheel.

Different cams are used for moving the card-carrier chains when it is

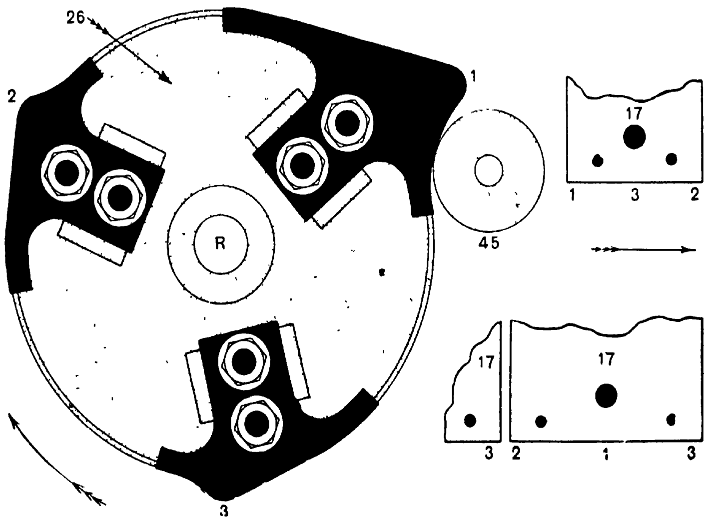


FIG. 217.

necessary to lace cards for 400's and 600's jacquard machines. Fig. 217 illustrates the three cams for 600's jacquard cards, part of two of which appear in the bottom right-hand corner. Cams 1, 2, and 3 cause the ratchet-wheel in Fig. 218 to move through the distances represented by the same numbers, and the card to move through one wide gap on the card, and two shorter gaps as exemplified. Cams 2 and 3, Fig. 217, are used for moving the 400's cards through the corresponding spaces, but a cam smaller than the one marked No. 1 must replace this one, because the distance between the holes in the 400's card at the top of the drawing is shorter than the corresponding distance between the holes in the 600's card at the bottom of the drawing.

In all cases it is found desirable to release a brake on the card chain

shaft when the cams and the ratchet-wheel are acting, and to apply the

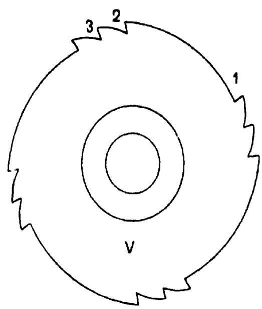


FIG. 218.

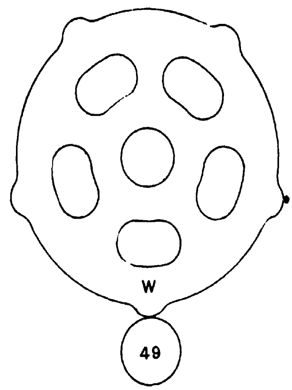


FIG. 219.

brake when the motion is completed. The cam W and bowl 49 for operating the lever to the brake are illustrated in Fig. 219; the position shown is that when the brake is off.

A general photographical view of the machine, taken from the back, is illustrated in Fig. 220.

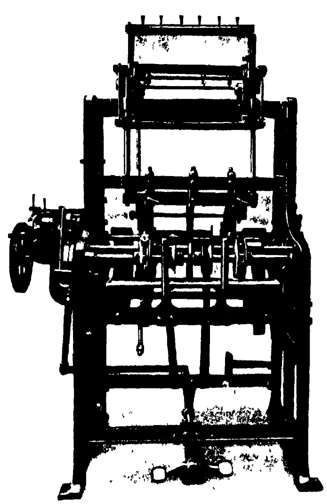


FIG. 220.

The elevations of the feed and delivery sides of the "Rapid" machine appear first because the main driving shafts are most clearly exhibited in these views, which are reproduced in Figs. 221 and 222 respectively. In both views the driving belt A is on the loose pulley B, adjoining which is the usual fast pulley C, both pulleys being placed on the short driving shaft D. On the extreme end of this driving shaft is a balance and hand-wheel E, while on the inner end of the shaft is a small pinion F of 28 teeth; this pinion is shown best on the feed side in Fig. 221, but is shown in Fig. 222 a little wider than the actual width in order to emphasise its position in that view.

The driving shaft is supported by two brackets G and H fixed to the

frame J. The small pinion F drives the wheel K of 75 teeth on the main shaft L of the machine. Not far from the frame opposite to the driving end, and on the same shaft L, are two pinions M and N of 18 teeth and 28 teeth;

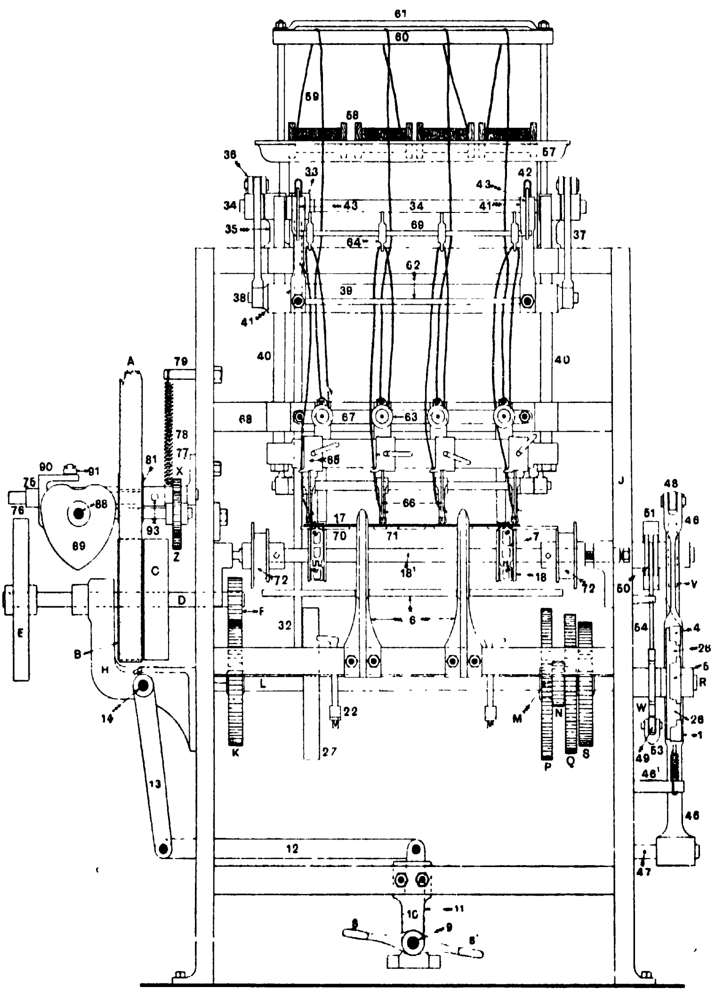


FIG. 221.

both pinions are fixed on the extended boss O. Pinion M is intended to drive, and is shown geared with, the wheel P of 90 teeth, while pinion N is intended to drive at other times the wheel Q of 84 teeth. When this change is necessary, the boss O is slid to the left in Fig. 222, a movement

which would withdraw the pinion M from gear with the wheel P, and

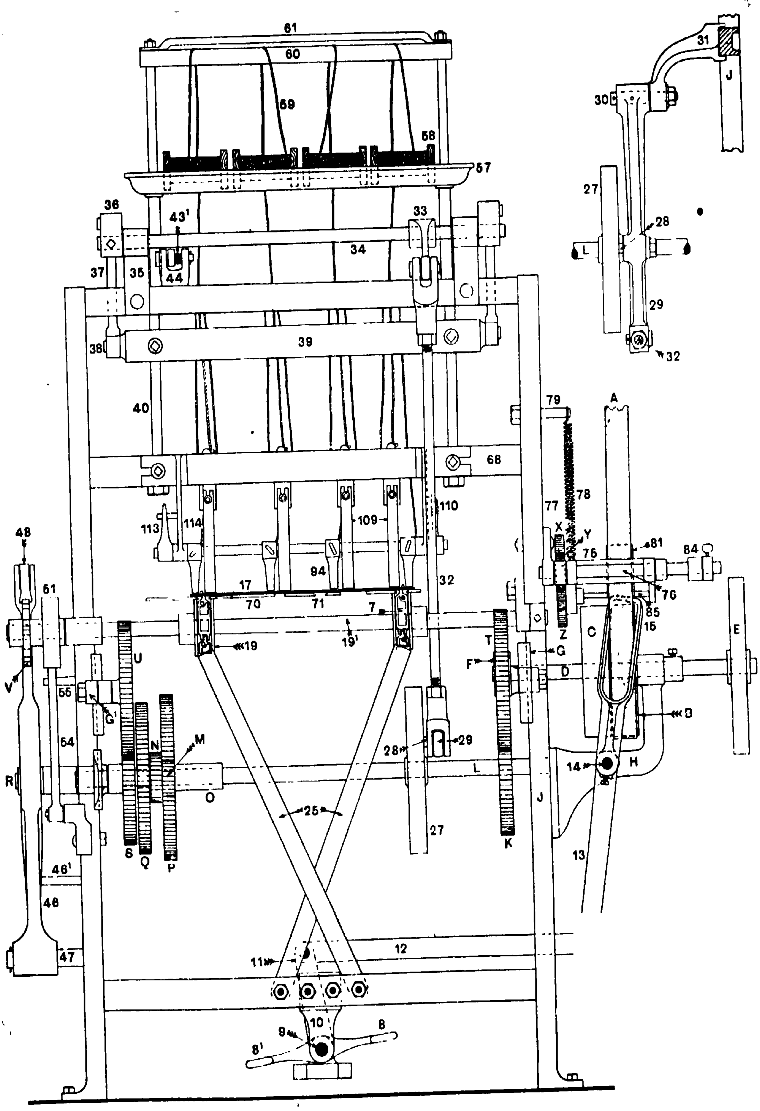


FIG. 222.

place the pinion N in gear with the wheel Q. Both wheels P and Q are on the camshaft R; this shaft is not shown clearly in Figs. 221 and

222, but it is the shaft which carries the cams illustrated in Figs. 215 and 217.

On the above-mentioned shaft L, and beyond the pinions M and N, is a wheel S of 75 teeth, and identical with the wheel K near the frame at the driving side. Wheel K gears with wheel T, Fig. 222, and wheel S with wheel U; the wheel T is supported by a stud near the end of the bracket G, while the wheel U is supported in a similar manner near the end of the corresponding bracket G^1. Both brackets G and G^1 project from, and are bolted to, the outer edges of the frame J.

The cards 17 to be laced are placed in the receptacle 6 (seen clearly in Fig. 223), near which the attendant stands in order to feed the cards on to the pins or pegs of the chains 7, and to be able to control quickly and easily the treadles 8 and 8^1. The combined treadles are fulcrumed on a shaft 9, which extends to the delivery side of the machine, and is supported at the two places by brackets 10. Near the cross-rail of the delivery side, and inside the framework J, is a lever 11 secured to and rising from the shaft 9. A connecting-rod 12, Figs. 221 and 222, connects the upper end of the lever 11 with the lower end of lever 13 fulcrumed on the stud 14. The belt-fork 15 is also fulcrumed at 14, and hence, when the left-hand treadle 8, Fig. 221 (the right treadle in Fig. 222), is depressed, it follows that the levers and rods shown will cause the belt A to be placed on the fast pulley C by the belt-fork 15. Two cards 17 are in position in Fig. 223, and are supposed to have been taken from the pile illustrated on bracket 6. A longitudinal view of a single card is shown in each of Figs. 221 and 222.

The two endless card chains 7 bridge the gap between the adjustable chain carriers 18 and 19 on the shafts 18^1 and 19^1, pass partially round them, and under an adjustable tension roller 20, Figs. 223 and 224. The tension roller 20 is supported on a pin near the end of lever 21, and the rear end of the latter is loose on a pin in the bracket 22. The bracket 22 is supported as shown on the long flat bar 23, which is fixed to and near the cross-rail of the machine. A spring 24 connects the pendant arm of lever 22 with the adjustable part in the bracket 22, thus providing a flexible connection. When the laced cards reach the delivery side of the machine their edges pass on to the inner discs of the chain carriers 19, and the cards are thus lifted from the pegs of the chains 7 to be finally guided to the floor or into some suitable receptacle clear of all obstructions by the two guides 25, Fig. 222.

A rectangle 27, Figs. 221 and 222, is shown on the main shaft L. This rectangle is simply the side elevation of a box or positive cam, an enlarged view of which appears in Fig. 225. Running in the groove of the cam is an anti-friction roller, which rotates on a pin 28, Fig. 222, supported by a

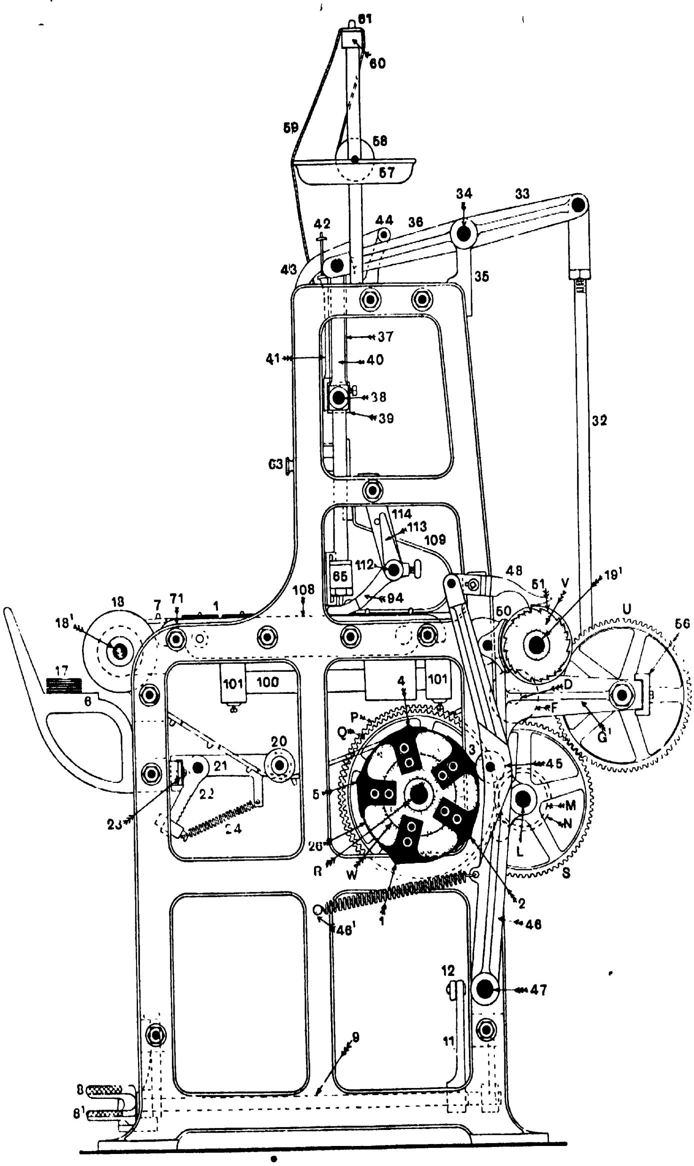


FIG. 223.

lever 29. A plan view of this lever and cam appears in the right-hand upper corner of this figure. Here it will be observed that the pin 28 is

placed about two-thirds of the length of the lever from the fulcrum 30,

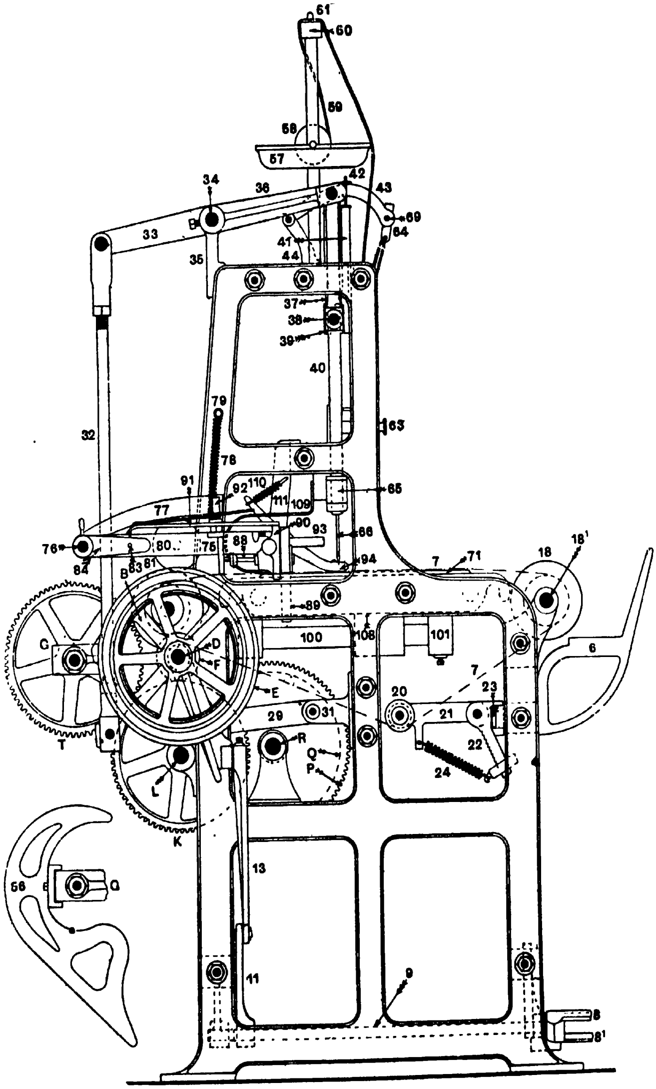


FIG. 224.

the fulcrum pin being fixed in a bracket 31 which is bolted to the midd
upright web of the frame J.

Attached to the end of the lever 29 is a connecting-rod 32, the upp

part of which is coupled to a lever 33 fulcrumed on the rod 34. This rod stretches across the machine, is supported by two brackets 35, and carries two levers 36, one near each end. The free ends of the two levers 36 are connected with the pendent arms 37, Figs. 223 and 224; and holes in the lower end of the latter enable them to encircle the studs 38 at the extreme ends of the horizontal rail 39, Fig. 222. A circular hole near each end of the rail 39 allows it to be raised and lowered in a true vertical plane by sliding on the two upright guide rods 40.

Fixed to the front of the rail 40, Fig. 221, are two arms 41, while at the top of each arm is an inverted U-shaped wire 42, and between the two legs of each wire the thread take-up lever 43 can move freely. Each thread take-up lever 43 is fulcrumed on a pin in the bracket 44. It will thus be seen that as the shaft L rotates, the box-cam 27 will cause the rod 32 to operate the levers and arms 33, 36, 39, and 41, and will thus convey the desired movements to the thread take-up levers.

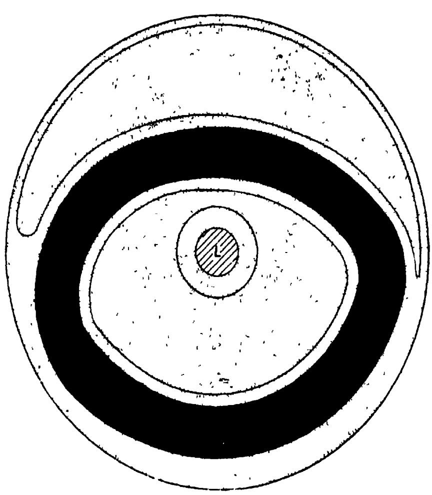


FIG. 225.

One complete cycle of movements of the thread take-up mechanism takes place every revolution of the box-cam 27 on the main shaft L, and a similar cycle takes place with the needles and shuttles. The mechanism for the latter will be described and illustrated later. And for each cycle of movements of the needles and the shuttles the jacquard card must be moved a distance between successive holes on the card, or the distance between the last hole in one card and the centre of the gap between it and the next card. It therefore follows that the speed of the chain-carrier shaft 19^1 will depend upon the number of lacing holes in the width of the card.

The disc 26 is provided with five cams for the cards used in the Brussels-carpet jacquard, and hence there must be one revolution of the shaft L for each of the cams 1, 2, 3, 4, and 5, or five revolutions of the shaft L for one complete revolution of the camshaft R. It has already been pointed out that pinion M, Fig. 222, has 18 teeth and wheel P has 90 teeth; hence,

since the speeds of the shafts are inversely proportional to the numbers of teeth in the wheels on the shaft, it follows that

$$\frac{\text{Revolutions of shaft R}}{\text{Revolutions of shaft L}}=\frac{1}{5}; \text{ or}$$

$$\frac{M}{P}=\frac{18}{90}=\frac{1}{5}, \text{ the ratio required.}$$

When the disc 26 has three cams, as exemplified in Figs. 218 and 220, the pinion N, Fig. 222, must be in gear with the wheel Q, when the ratio of the shafts R and L will be

$$\frac{N}{Q}=\frac{28}{84}=\frac{1}{3},$$

because the shaft L must in this case make three revolutions for each revolution of the cam-shaft R.

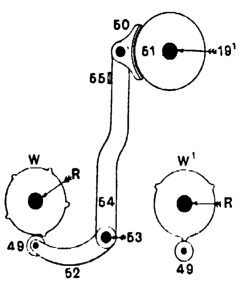


FIG. 226.

As the camshaft R revolves (see Fig. 223) the five cams, 1, 2, 3, 4, and 5, working clockwise, come successively against the anti-friction roller 45 in the lever 46, fulcrumed at 47; and, since the upper end of the lever 46 controls the adjustable pawl 48, it follows that the latter will cause the ratchet-wheel V to move the varying distances necessary for correct lacing. The adjustment of the end of the pawl 48 is so that the extreme end can be set to make sure of moving to the next tooth each time; the distance through which the pawl actually moves depends obviously upon the strokes of the various cams on the disc 26. After the lever 46 has been released by the cam, it is returned into close contact with the disc 26 by means of a spiral spring attached to the lever 46 and to a stud 46^1 projecting from and fixed to the end frame.

The brake-cam, together with the remaining mechanism, is illustrated in Fig. 226. The cam W, with five projections (the same cam illustrated in Fig. 219), is for use in connection with the five cams on the shaft R, while the cam W^1 to the right in the detached view is used in conjunction with the three cams illustrated in Figs. 217 and 220, and with the ratchet-wheel shown in Fig. 218. The mechanism shown in Fig. 226 occupies a position between the frame J, Fig. 223, and the disc 26; hence the method of illustrating this part in Fig. 226.

As the cam-shaft R rotates, the projections on the brake-cam W operate on the anti-friction bowl 49 in unison with the action of the five cams on the anti-friction roller 45 in lever 46. In Fig. 226 the brake 50 is on, the

leather face gripping the brake-wheel 51. One of the projections on the cam W is just about to act, and when this occurs it is evident that the anti-friction roller 49 will cause the lever 52, fulcrumed at 53, to move slightly counter-clockwise, and simultaneously the brake lever 54, on the same fulcrum, will make a corresponding angular movement in the same direction, and will thus create a gap between the brake 50 and the brake-wheel 51 just when one of the five cams on the disc 26 commences to move the anti-friction roller 45. When the projecting point of the cam W leaves the anti-friction roller 49, a double flat spring 55 forces the brake 50 again into close contact with the brake-wheel 51.

The wheels T and U, Figs. 223 and 224, stand well out from the frame J because of the function which they have to perform, and which will be described and illustrated shortly; the operative is protected from these wheels by suitable guards when she has occasion to perform any duty at the delivery side. One of these guards is shown detached at 56 in Fig. 224; part only of the corresponding one is shown bolted, or, rather, set-screwed to the bracket G^1 in Fig. 223. In some machines the shaft R extends across the frame, and in these cases a bracket is placed on the frame as indicated in Fig. 224.

The upper lacing twine, if on cheeses or bobbins, may be placed on a rod in a suitable position. When the lacing twine is in balls, each ball may have a separate bowl, or all may be placed in a long dish 57, Figs. 221 to 224, in similar positions to the bobbins 58; hence a dish is suitable for balls of all kinds.

The upper lacing twine 59 in these figures first passes upwards and between the rods 60 and 61, then downwards behind the rod 62, Fig. 221, through a guide curl, and round the tension apparatus 63. It is then carried upwards in front of rod 62, through an eye in the thread take-up bracket 64 (see also Fig. 224), then behind rod 62, through an eye in the needle-holder 65, and finally through the eye of the needle 66 as exemplified.

In Fig. 221 there are four needle-holders 65 for the four rows of lacing, but any desirable number may be accommodated and placed at any position, since each needle-holder 65 is adjustable on the flat rod 67, Fig. 221. This flat rod is fixed to the cross-rail 68 as shown. Similar provision is made for the adjustment of the thread take-up brackets 64, for all are carried on the rod 69, and the two ends of the latter are operated by the thread take-up levers 43.

The cam 27, Figs. 221 and 222, through rods and levers 32 to 41, causes the thread take-up levers to operate somewhat similarly to that already described in connection with the foregoing lacing machine. The springs 43^1, Fig. 222, acting on the underside of the thread take-up levers 43 help to secure the necessary movements of the latter.

Fig. 227 illustrates a plan of the machine with the upper lacing mechanism and all parts above the needles omitted; it also shows the best view of the cop winding mechanism.

One full-width card is illustrated in each of Figs. 221 and 222, and three

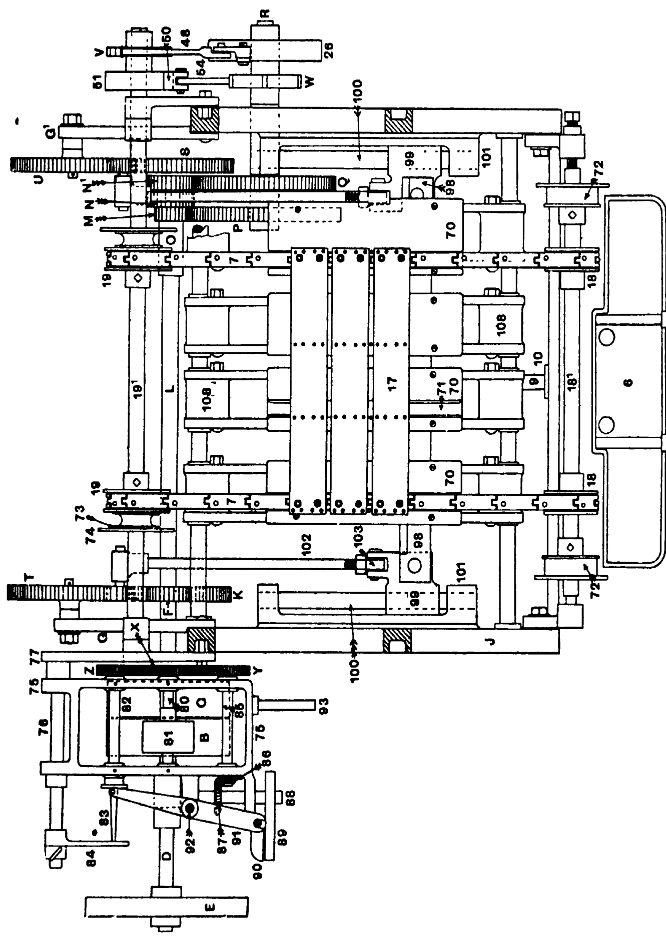


FIG. 227.

full-width cards are shown in Fig. 227, but no lacing twine is exhibited, since the method of lacing has already been demonstrated.

Provision is made for the lacing of shorter cards than those illustrated. In Fig. 227 the two chains 7 are shown in their respective chain races in the plates 70, and in position for conveying wide cards. An extra chain race is, however, shown at 71, and opposite this race either of the chain

guides 18 may be fixed. Enlarged views of a pair of links from each chain appear in Fig. 228. If a chain with larger links is required, say, for wide cards such as those used on a 600's jacquard machine, each link for one chain is similar to that illustrated in the extreme right-hand bottom corner of Fig. 228, and the larger chain guides 72, Fig. 227, placed in position. In addition, the chain conveyers 19 are moved inwards, so that the wide flat surfaces 73 may draw the cards forward, and the larger discs 74 lift the cards from the pegs of the chain 7.

The whole of the mechanism for winding the lower lacing twine is outside the main frame, and supported by a supplementary frame immediately above the pulleys B and C. This supplementary frame 75 is fulcrumed on a shaft 76 in the bracket 77, while a spiral spring 78 from a stud 79 is attached to a hook in the supplementary frame 75, and thus keeps the whole frame and mechanism in the highest position.

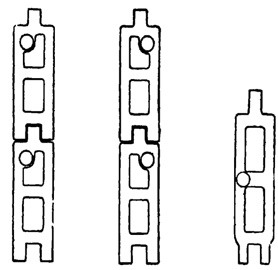


Fig. 228.

A shaft 80 near the middle of the frame carries a leather-faced pulley 81, while on the same shaft and near the main frame is a wheel X of 60 teeth. Wheel X drives two wheels Y and Z of 60 and 28 teeth respectively. Wheel Z is on the shaft 82, and at the other end of the shaft is the spindle 83 upon which the lacing twine is wound in the form of a small-diameter cheese.

The bracket 84 is in the position shown when the winding is in process, but it can be withdrawn from the end of the spindle when it is desired to remove the cheese or cop. Wheel Y drives a further shaft 85, on the end of which is a bevel pinion 86; the latter drives a larger bevel-wheel 87 on the short shaft 88, and on the extreme outer end of the shaft 88 is the box-cam 89. An enlarged view of the cam appears in Fig. 229. An anti-friction roller, supported by the bracket 90, Fig. 227, runs in the groove of the cam 89, and since the bracket is attached to the lever 91 fulcrumed at 92, it follows that the free end of lever 91 will oscillate above the spindle 83. A hole in the free end of lever 91 forms the thread guide.

The lacing twine is first wound round the projecting part of the fulcrum, and then through the eye of the lever 91. The operator allows the twine to run through a tallowed cloth held in one of her hands, and with the other she presses down the handle 93 in the frame 75 until the rotating loose pulley B imparts its circumferential speed to the winding pulley 81. She is thus able to grease the twine and to detect knots at the same time as she is winding the cheeses. It will be understood that no knots are allowed to

pass on to the cheese. When the cheese, which is about $3\frac{3}{4}$ in. long, has reached a diameter of about $1\frac{1}{2}$ in., the handle 93 is released, the mechanism stops, and the cop or cheese is withdrawn from the spindle 83 in the usual way after the bracket 84 has been removed as already explained.

An enlarged view of part of a card for a Brussels-carpet jacquard is shown in Fig. 230 with the presser foot 94 and the needle 95 in position. A grooved wheel 96 is supported by the forked ends of the presser foot. This wheel serves a double purpose: it facilitates the movements of the cards 17, Fig. 227, over the plates 70, and acts as a guide for the up-and-down movements of the needle 95, Fig. 230.

In the plan view, Fig. 227, the wheels M and N are shown in three positions. It will be understood that the letters M and N represent the positions occupied when five cams are used; but when three cams are

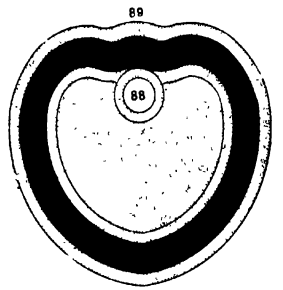


FIG. 229.

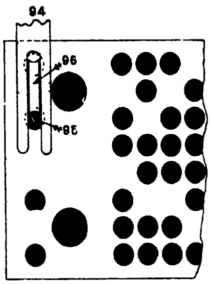


FIG. 230.

used, the wheel N goes to the position marked N¹, and wheel M occupies the position thus vacated by wheel N.

A sectional view of the chief parts of the machine is shown in Fig. 231, and this view, considered along with the part plan view in Fig. 232, illustrates the mechanism for the lower lacing twine. An enlarged view of a needle 95, which, naturally, works in conjunction with the lower lacing mechanism, is shown in Fig. 233. The sectional view, Fig. 231, shows that the needle 95 is approximately in its lowest position, with the thread take-up lever 43 in its lowest position, and the upper lacing twine 59 quite slack. These are the positions of the parts when the tip of the shuttle is just about to enter between the needle 95 and the loop formed by the twine 59 a little above the eye of the needle. It will thus be seen that the shuttle, although not shown in Fig. 231, is supposed to be on the right of the needle, and is, in fact, in the actual apparatus in the shuttle carrier immediately behind the plate 96, to which the shuttle carrier is fixed by two screws as indicated.

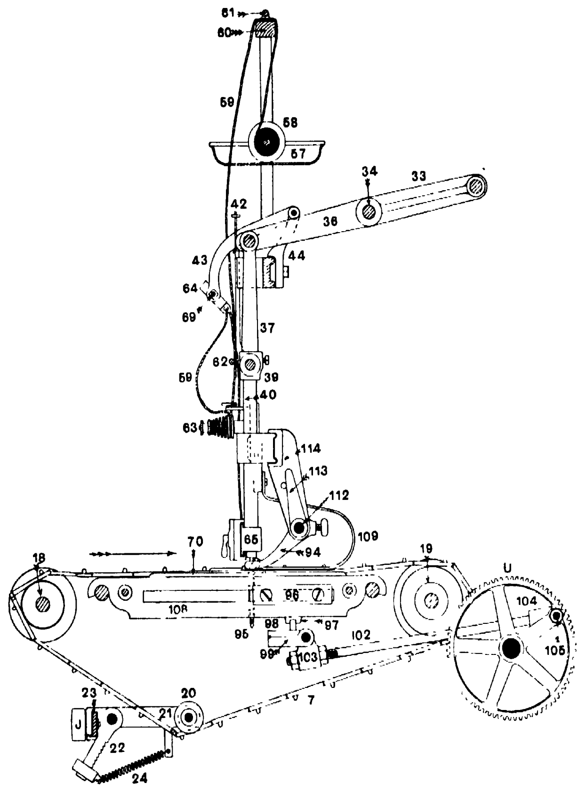


FIG. 231.

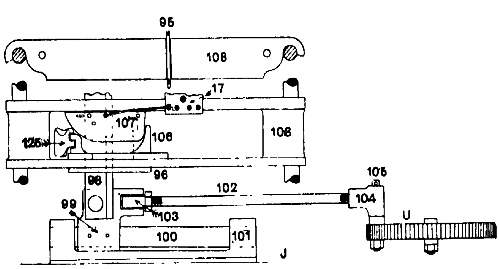


FIG. 232.

FIG. 233.

All four shuttle carriers are obviously in the same plane, and all ar connected separately by pendent arms 97 to the flat bar 98 which stretche

across the machine (see Fig. 227). Near the ends of the flat bar 98 are bolted two brackets 99, the outer ends of which encircle two shafts 100. These two shafts 100, one at each side of the machine, are secured to brackets 101 on the side frames J, and on these shafts the brackets 99 can slide. The forked part of each bracket 99 is attached as shown in Figs. 231 and 232 to a rod 102 by the swinging bracket 103. The other end of the rod 102 is attached to the bracket 104, and this bracket encircles a stud 105 near the periphery of the wheel U. A similar connection is made at the other side of the machine. It will thus be seen that, since wheels K, S, T, and U, Fig. 222, are equal in size, the wheel U, Figs. 231 and 232, will make the same number of revolutions as the main shaft L. This is necessary, because the movements of the shuttles must synchronise with those of the needles and the thread take-up levers.

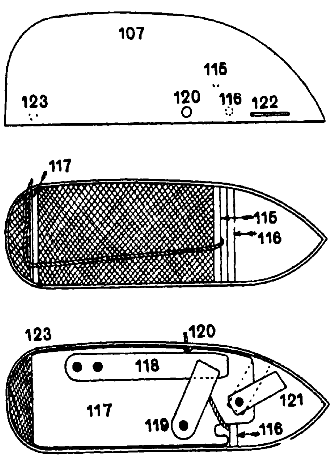


FIG. 234.

The shuttle carrier 106, Fig. 232, holds the shuttle 107 in the manner indicated. A planed projection of the shuttle carrier passes through the slot in the plate 108, Fig. 231, and this projection is attached to the outside plate 96 by the two screws. As the wheel U rotates, the planed projection slides backwards and forwards in the slot of 108, and thus the desired movements of the shuttle carriers and the shuttles are made.

While the lacing is in progress, springs 109, Fig. 231, in conjunction with the presser feet 94, keep the cards 17 on the pins of the chains 7, and yield slightly if any obstruction occurs. The presser feet are sometimes held down separately by springs as shown in Fig. 220; but in the line drawing (see Fig. 224) a small spiral spring 110, attached to the bracket 111 and to a projecting arm on the shaft 112, Figs. 223 and 231, serves the same purpose. The lowest position of the presser feet is determined by a similar arm 113 abutting against a projecting pin in the bracket 114.

Three views of the shuttle 107 appear in Fig. 234. The criss-cross marks in the central view represent the cop, and in this view the lid of the shuttle is open. In the lower view, however, the lid is closed, but not fastened down. The thread—or, rather, the lacing twine from the inside of the cop—is first passed between the pins 115 and 116 as shown, and then the lid is closed down. The lacing twine is then passed between the

pin 116 and the slot in the lid 117, under the spring 118, which is kept down by another spring 119, and finally through the hole 120 in the side of the shuttle. The locking plate 121 is now rotated to the dotted position, when its end will have entered the slot 122 in the side of the shuttle. The lid 117 is hinged at 123.

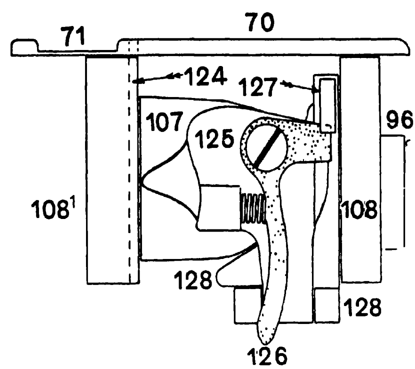


FIG. 235.

Figs. 235 and 236 are further views of the shuttle and shuttle carrier, with provision for the entrance and withdrawal of the shuttle. The face of the shuttle 107 slides against the part 108¹, just clearing the needle which moves up and down in the slot 124, and through a hole in the plate 70. The card chain moves in the slot.

In Fig. 232 the shuttle carrier 106 and the shuttle 107 are shown on the extreme left, and at this time the needle would be in the highest position. The hinged end or door 125 of the shuttle carrier is open in this view, and also in Fig. 236. Both views show the necessary position of the door when the attendant is putting in a shuttle or taking one out. When the machine is in work, however, the door must be up or closed, as indicated in Fig. 235. It is kept secure in this closed position by a spiral spring which exerts its pressure against the pendent arm of lever 126, shown stippled, such pressure causing the upper arm of the lever 126 to pass behind the fixed retaining part 127. The door is hinged at 128 to the shuttle carrier. To open the door it is only necessary to pull the long arm of lever 126 to the left, when the upper horizontal arm will clearly leave the retaining part 127, and allow the door to rotate to the lowest position as exemplified in Fig. 236.

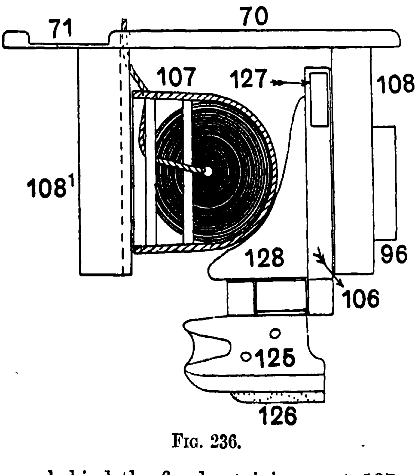


FIG. 236.

The shuttle 107, shown in section in Fig. 236, rests as indicated upon two projecting parts 128 of the shuttle carrier 106; one only is shown in this figure, but both are dotted in Fig. 232. When this door 125 is down, the shuttle can be withdrawn to replace a new cop, after which the shuttle is again entered, the door 125 raised, and all is ready for continuing the lacing operation.

The relative positions of the needle and shuttle in Figs. 231 and 232 are indicated in Table IX.:

TABLE IX.

Needle down when the shuttle is on the extreme right.
Needle commences to move slightly when shuttle commences to move to the left.
Needle stops, and remains stationary, while shuttle tip is entering the loop, and also for a time during which the upper lacing twine is drawn through the needle eye to accommodate the increasing bulk of the shuttle.
Needle commences to rise when the shuttle is about one inch from the extreme left.
Needle reaches the top, or nearly so, at the same time that the shuttle reaches the extreme left.
Needle commences to move down when the shuttle has moved about one inch towards the right.
Needle just entering a hole in the card, or the gap between two cards, when the shuttle is opposite the needle or midway in its travel.

The speed of the machine depends naturally upon several considerations. In an illustrated handbook by the makers it is stated that "1000 cards or more per hour" can be laced. Under suitable conditions this number could probably be exceeded with three stitches per card, for the machine from which the foregoing drawings were made was running splendidly at 84 stitches per minute. This means a non-stop production of

$$\frac{84 \times 60}{3 \text{ stitches}} = 1680 \text{ cards per hour; or}$$

$$\frac{84 \times 60}{5 \text{ stitches}} = 1008 \text{ cards per hour.}$$

Even if 25 per cent be deducted for stoppages, the production is highly satisfactory.

CHAPTER XIV

MECHANICAL METHODS OF STITCHING CARDS

THE card-stitching machine made by the Singer Manufacturing Company. Limited, is very similar in build to that of the card-lacing machine described in the foregoing chapter; it differs from it entirely, however, in the way of forming the cards into a continuous length; the materials which are used to effect the chain-like form of the cards also differ essentially in the two systems of attachment. As already seen, the lacing machine is provided with two balls or two cheeses—as the case may be—of comparatively thick and level twine for each head; this twine may be of some multiple ply twisted in the ordinary way, or it may be made from about eight separate threads braided on the box-cord principle.

On the other hand, each head of the stitching machine combines two narrow tapes—often the braided circular cord flattened—one above the cards and the other below the cards, by means of two fine sewing threads. Such being the case, the mechanism for the stitcher, although similar in some respects to that of the lacer, is of a lighter build.

Fig. 237 is a general photographical view of the machine; it is nearly a full front view of a 4-head machine, but it also shows most of the mechanism on the right hand—the driving side—and a half-full view of the spool-winding mechanism.

The line drawing illustrating a front elevation of the machine is shown in Fig. 238, but in this case only three heads are illustrated. The corresponding line drawing of the driving end of the machine is illustrated in Fig. 239. The machine may, of course, be driven either from above or below, and in both cases the belt from a drum on the driving shaft communicates motion to the stitching machine belt pulley A on the main shaft B, which is made to revolve counter-clockwise when viewed from the driving end as indicated in Fig. 239.

Near to the belt pulley A, Fig. 238, and between it and the frame of the machine, is a hand-wheel C and the cone D. The latter enters a corresponding recess in the driving pulley A, and these two, together with

the treadle E and the intermediate mechanism, enable the operator to start and stop the machine at will. The treadle E is fulcrumed on the rod F, and on the same rod is fixed the lever G, the free end of which is connected to the lower and horizontal arm H^1 of the driving shaft friction

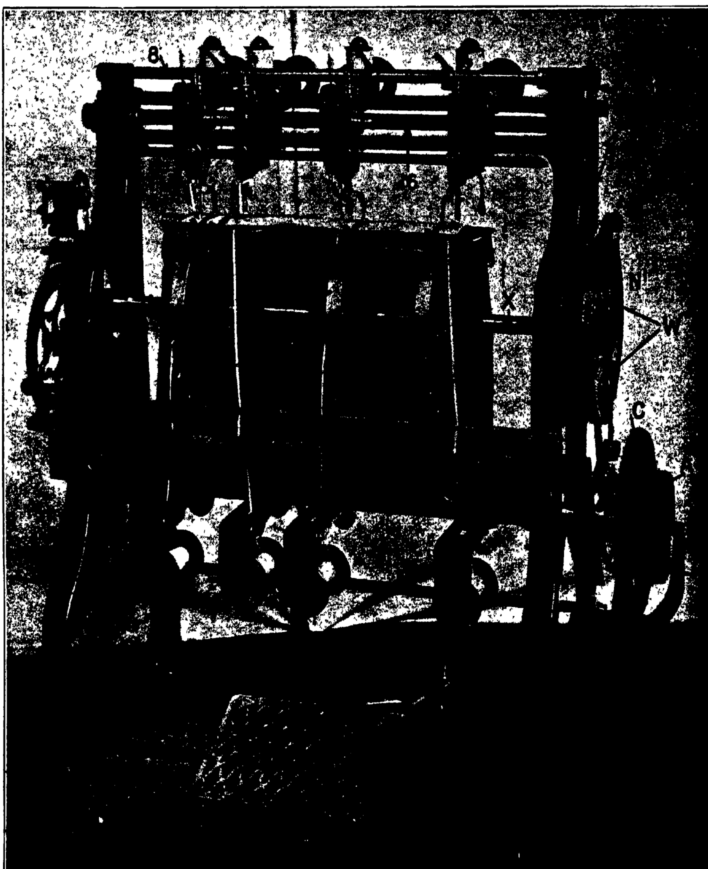


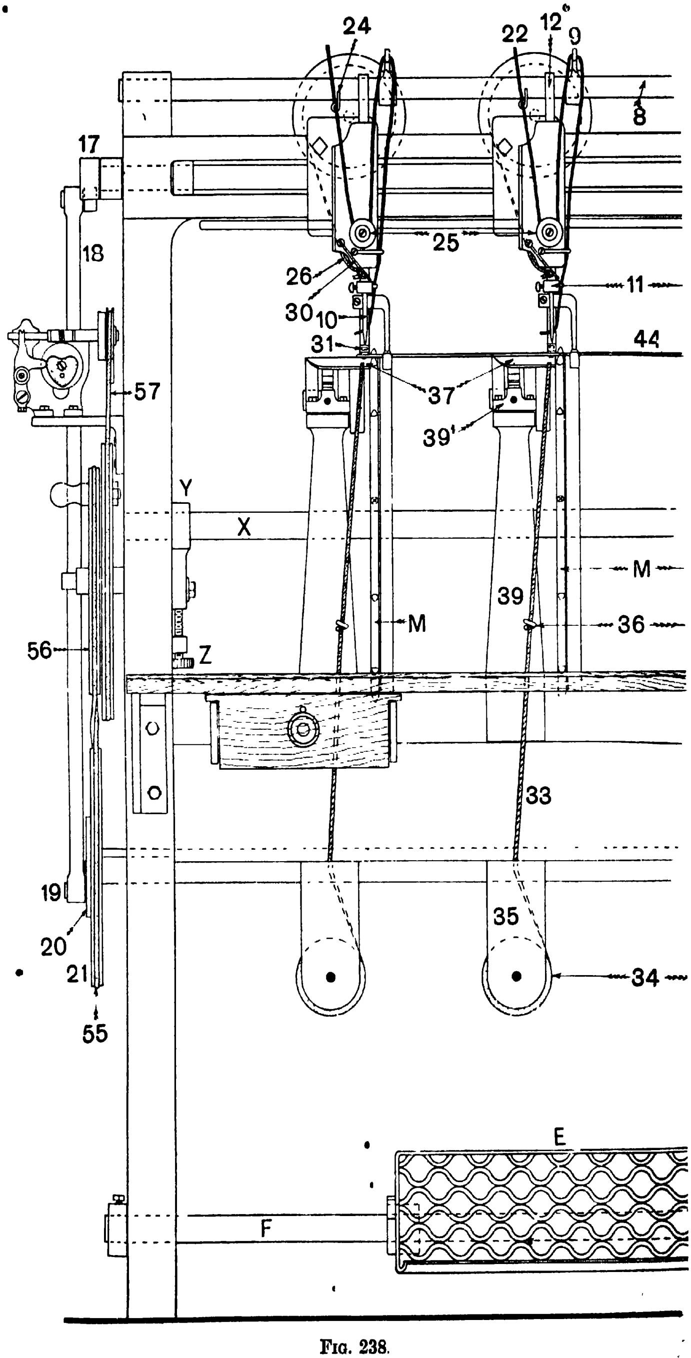
FIG. 237.

lever H by means of the link J. In some cases, as shown clearly in Fig. 237, a projection from the back of the treadle E serves the same purpose as the lever G in Figs. 238 and 239.

The friction lever H, Fig. 238, is fulcrumed at K, and, in addition to its horizontal arm H^1, is provided with two vertical arms H^{11} and H^{111}; the

arm H^{11} is in close contact with the pointed end of the small bush L on the belt pulley A, while the side of the upper end of the arm H^{111} is provided with a leather face to form a brake when it comes into hard contact with the face C^1 on the side of the hand-wheel C. In the absence of any pressure on the inner half of the treadle E—that farthest from the operator—the weighted outer half keeps the treadle in the low position as indicated in all the figures. When the treadle is in this normal position, the leather face of the arm H^{111} is in contact with the face C^1, but there is a gap between the outer surface of the cone D and the inner surface of the belt pulley A. If, however, the inner half of the treadle E be pressed downwards, it is evident that the lever G will move in unison, and will cause the lever H to make a slight movement counter-clockwise, Fig. 238, while simultaneously with these actions the brake lever H^{111} will be withdrawn from contact with the face C^1, and the upper end of the long vertical arm H^{11} will push the belt pulley A, and therefore the inner surface of the cone, into close contact with the outer surface of the cone D. The friction thus introduced will start the machine.

It was shown in connection with the lacing machine that it was necessary for the feed-wheels to move varying distances, such distances depending upon the space between adjacent lace-holes on the card, and the space from the last lace-hole on the card to the centre of the gap between adjoining cards. In the machine under notice the peg-wheels cover the same distance each movement, and this distance is much less than that required for the feed-wheels in the lacing machine. In some of the stitching machines—not those of the latest design—the peg-wheels are moved through the necessary distance by means of a feed friction-wheel and friction blocks (see N^1, Fig. 237), but in the latest type the corresponding movement of the peg-wheels M is obtained by means of a ratchet-wheel N, Figs. 238 and 239, and the usual pawl O, the latter of which is operated as follows: On the main or driving shaft B and near the frame, Fig. 238, is a disc P. A positive or box cam Q, Fig. 240, is cut into the right-hand face of the disc P, and a different box cam 2, Fig. 241, is cut into the left-hand face of the disc. An anti-friction bowl R, Fig. 239, enters the grooved cam Q, while the bowl itself rotates on a pin which projects from the side of the long arm of the lever S fulcrumed at T. The curved and shorter arm of the lever S, Fig. 239, is provided with a concentric slot S^1, through the medium of which one end of the link U can be adjustably fixed to the curved arm S by the wing-nut V; the other end of the link U is attached to the lower arm of the feed lever W fulcrumed on the feed-wheel shaft X. The latter is supported by the brackets Y, Fig. 238, which may be raised or lowered slightly for the adjustment of the peg-wheels M by reason of the milled-headed screws Z. The feed-wheels in Figs. 238 and 239 are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22
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17
18
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26
30
10
11
31
44
57
37
39'
Y
X
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36
56
Z
33
19
35
20
34
21
55
E
F

Fig. 238.

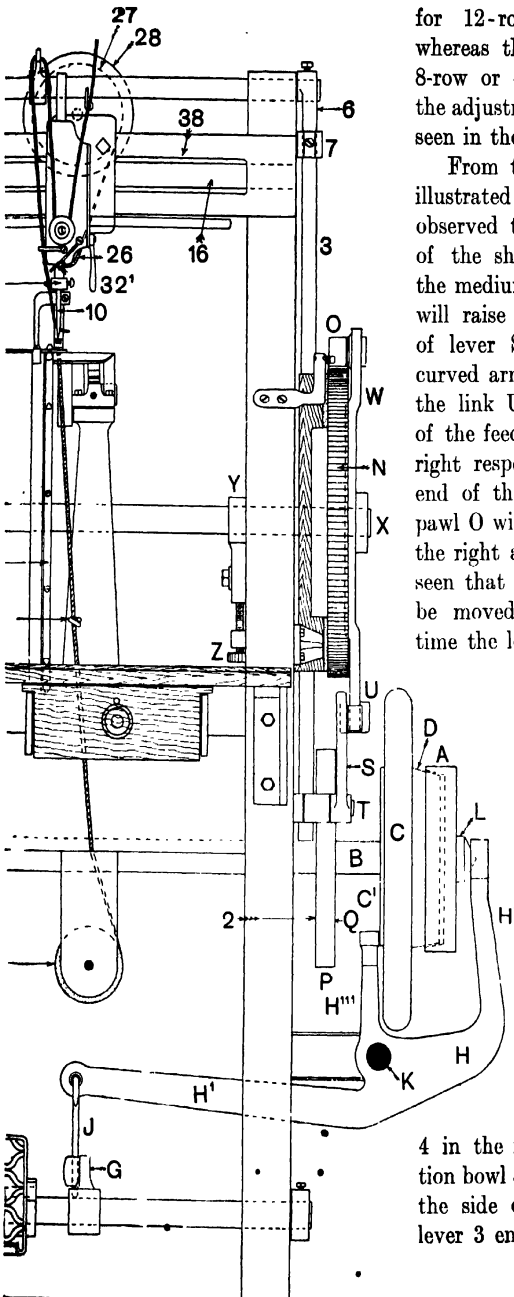
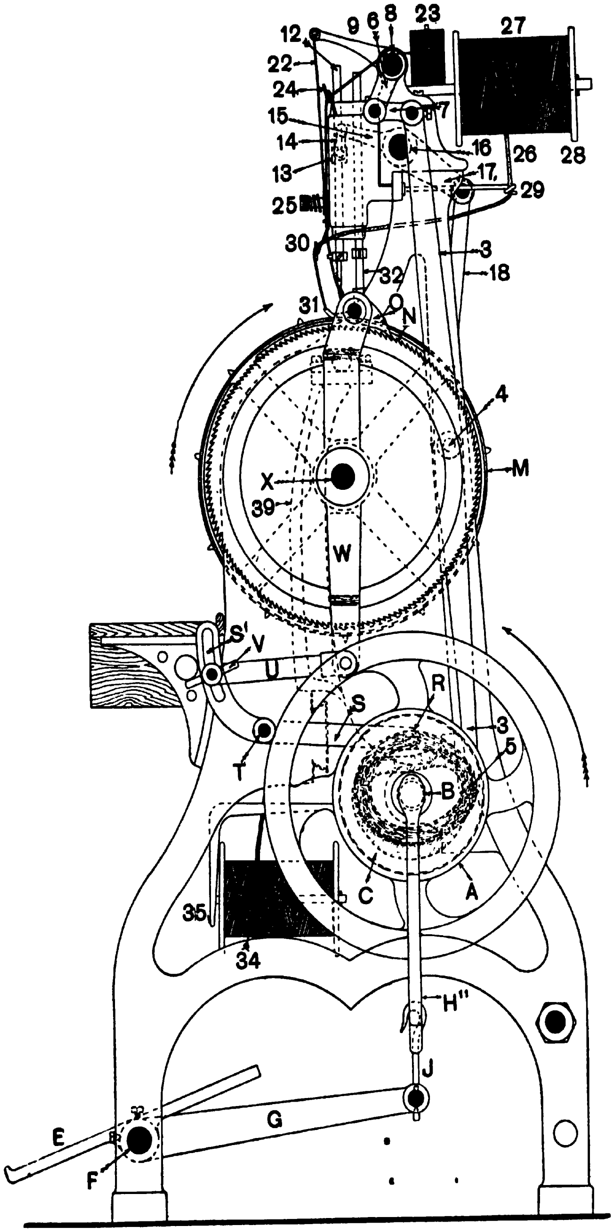


Fig. 238.

for 12-row or 600's jacquards; whereas those in Fig. 237 are for 8-row or 400's jacquards. One of the adjustment brackets Y is clearly seen in the latter view.

From the position of the parts illustrated in Fig. 239 it will be observed that for every revolution of the shaft the cam Q, through the medium of the friction bowl R, will raise and lower the long arm of lever S, and hence the short curved arm of the latter will cause the link U to move the lower end of the feed lever W to left and to right respectively, while the upper end of the feed lever W and the pawl O will move in unison, but to the right and left. It will thus be seen that the ratchet-wheel N will be moved by the pawl O every time the long end of the lever S is raised by the thick part of the cam Q, and that the correct length of movement of the pawl O can be obtained by the proper adjustment of the link U in the curved arm of the lever S.

The cam 2 on the left-hand face of the disc P, Figs. 237 to 241, is for the thread take-up mechanism. The long lever 3, Fig. 239, is fulcrumed on a stud 4 in the framework. An anti-friction bowl 5 on a pin projecting from the side of the lower end of the lever 3 enters the cam 2, while the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18
31
O
N
4
X
M
39
W
S'
V
U
R
S
3
T
5
B
35
C
A
34
H''
J
G
E
F

Fig. 239.

upper end of the lever 3 is attached to the thread take-up rock-shaft lever 6 by the link 7. The lever 6 is fixed to the thread take-up rock-shaft 8 by means of set-screws, while a thread take-up lever 9 of the usual kind for each head is also fixed to the rock-shaft 8.

The nature of the movements of the thread take-up levers is similar to that already described in connection with the lacing machine, and need not be recapitulated; it is sufficient to say that as the cam 2 rotates, the lower end of the lever 3 will be moved at the proper times alternately to right and to left, while the upper end of the lever 3 will reciprocate oppositely, and through the link 7 and the lever 6 will cause the rock-shaft 8 to rotate clockwise and anti-clockwise through the necessary angle for the various essential movements of the thread take-up levers 9.

The needle 10, Fig. 238, is connected in the usual way to a needle clamp 11 near the bottom of the needle bar 12. A line drawing of the end opposite the driving pulley is shown in Fig. 242.

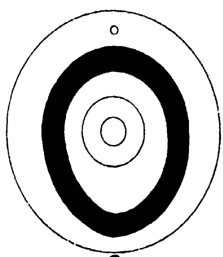


FIG. 240.

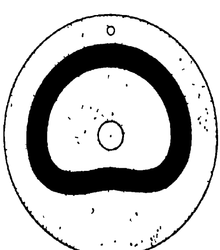


FIG. 241.

On the needle bar 12, and inside the head, is fixed a collar 13, from the side of which a pin projects to provide means of completing the connection, through the link 14 and the lever 15, to the needle bar rock-shaft 16. On the end of this shaft—outside the frame—is fixed the needle bar rock shaft crank 17, and from a pin projecting from the side and near the end of the crank 17 is placed the connecting-rod 18. Finally the lower end of the rod 18 is placed on a similar pin 19 projecting from the face of the disc 20 on the grooved wheel 21; the latter is on the reduced end B^1 of the main shaft B. Consequently, as the main shaft B revolves, the needle 10 will be raised and lowered in the well-known manner.

The upper sewing thread 22 for the needle 10 comes from a bobbin or cheese 23, seen best in Figs. 239 and 242; it is passed first through a wire guide 24, then between the discs of the tensioning device 25, up and through an eye near the end of the thread take-up lever 9, and then down to and through a guide on the clamp 11, and finally through the eye of the needle 10. The lower sewing thread will be referred to later.

The tape 26 for the upper side of the card is led from the larger bobbin or cheese 27 (sometimes the cheese is inserted between discs 28), through

the wire guide 29, then through a similar wire guide 30 near the front of the machine, and finally down the guide of the presser foot 31, which is fixed to the presser rod 32. The latter is raised when required by the handle 32^1, Fig. 238. The tape 33, Figs. 239 and 242, for the underside of the cards comes from a similar cheese or bobbin 34, supported by a pin in the bracket 35, then through a wire guide 36, Fig. 238, and afterwards direct to the needle plate 37.

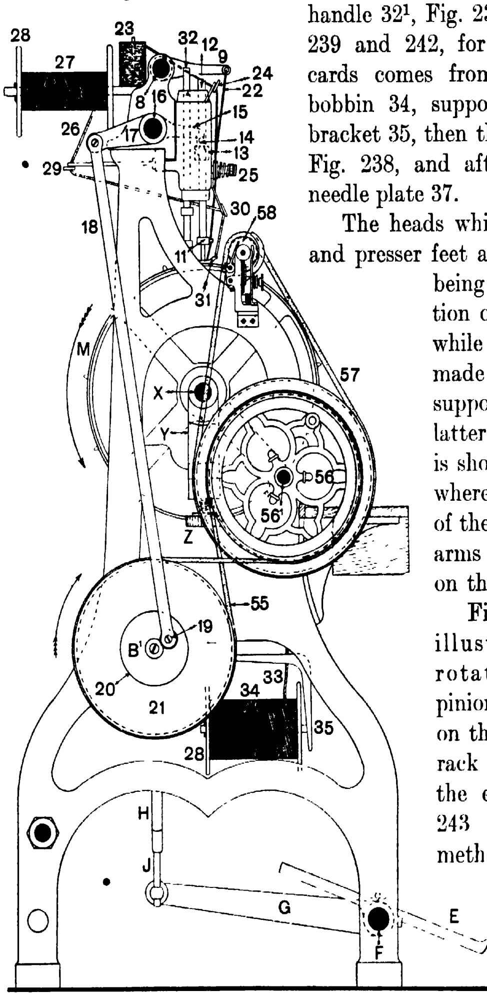


FIG. 242.

The heads which support the needles and presser feet are of course capable of being adjusted to any position on the rail 38, Fig. 238, while similar provision is made for the shuttle race supporting arms 39; the latter means of adjustment is shown clearly in Fig. 243, where the lower part of one of the shuttle race supporting arms 39 is shown dovetailed on the rail 40.

Figs. 243, 244, and 247 illustrate the method of rotating the shuttle race pinion 41 by the eccentric 42 on the main shaft B, and the rack 43^1 at the upper end of the eccentric rod 43. Fig. 243 also emphasises the method of lifting the cards 44 from the feed wheels M; this is done by the small bracket 45 secured to the side of the shuttle race 39^1, Fig. 243.

Special details of the shuttle race, shuttle carrier, and shuttle are illustrated in Figs. 246 to 258. Two end elevations are shown in Figs. 246 and 247; in the former view the shuttle 45 is in its working position, but in Fig. 247 its position is shown when it is necessary to remove an empty

spool 46, or to insert a full one. In Fig. 247 the empty spool is indicated as leaving the shuttle. The teeth of the rack 43^1 on the end of the eccentric rod 43, and the small pinion 41, are shown in Fig. 246.

A front view of the shuttle race 39^1 appears in Fig. 248, and when the shuttle frame and shuttle are placed in the race, the cap, Fig. 249, is placed in front, and secured by means of the spring 50, Fig. 250, and the screw shown detached. The short shaft 47, Figs. 246 and 251, which carries the pinion 41, passes through the central hole in the shuttle race 39^1, Fig. 248, and is naturally free to rotate in the said race. Fixed to this short shaft 47 is the shuttle driver, Fig. 251, and this driver is provided with two blunt projecting ends 48 and 49 which rest against the corresponding recesses 48^1 and 49^1 in the shuttle frame 51, illustrated in the upper view in Fig. 252. The position of the shuttle 45 is shown dotted in the shuttle frame 51. It will be evident that as the shaft B, Figs. 244 and 245, rotates, the eccentric rod 42 will cause the rack 43^1, at the upper end of the eccentric rod 43, to rotate the pinion 41 and the short shaft 47, and also the shuttle driver, Fig. 251, alternately clockwise and counter-clockwise; hence it follows that the drivers 48 and 49 will cause the shuttle frame 51, Fig. 252, to make similar oscillatory movements inside the shuttle race 39^1, Fig. 243. Two views of a spool 46 are shown in Fig. 252, and this spool carries the lower stitching thread 52.

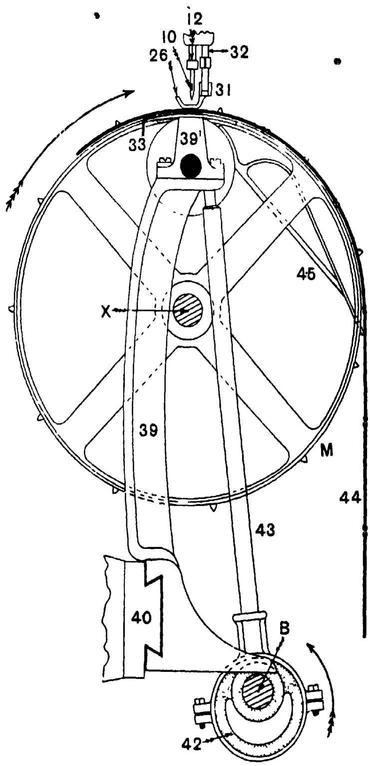


FIG. 243.

The lower sewing mechanism is illustrated completely in Figs. 253 to 256 inclusive. Fig. 253 shows the needle 10 through the tapes and card 44. The upper sewing thread 22 passes down the long groove side of the needle—the side nearest the thread take-up lever—out at the short groove side, and then to the stitched portion of the tapes and card. When the

needle reaches the lowest position it is caused to rise about $\frac{3}{32}$ in. in order

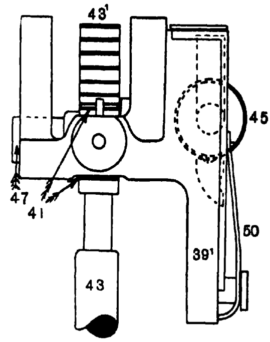


FIG. 246.

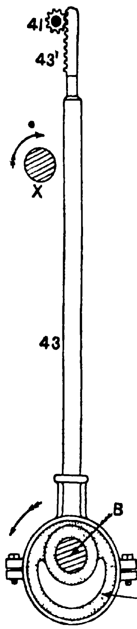


FIG. 244.

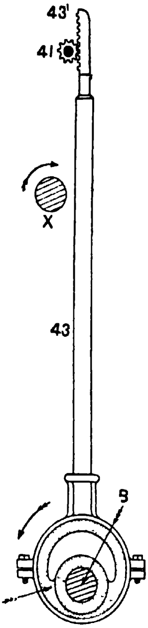


FIG 245.

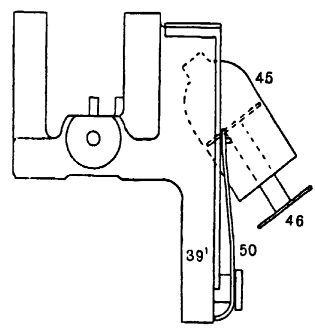


FIG. 247.

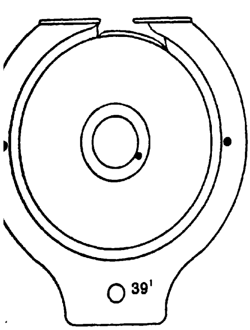


FIG 248.

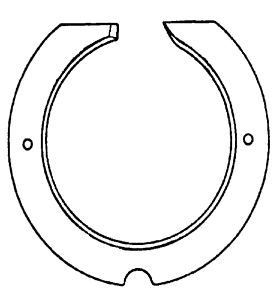


FIG. 249.

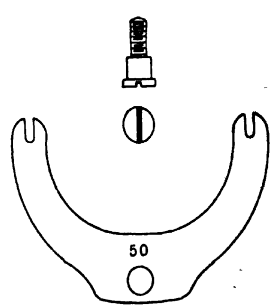


FIG. 250.

to form a loop for the point 54 of the shuttle frame to enter. The point 54 is shown entering the loop in Fig. 253, although the needle eye is

illustrated in a lower position than what actually obtains in practice, so that the loop might be seen more clearly. The needle eye is only about $\frac{1}{8}$ in. below the point 54 when the latter enters the loop. The point 48 of the shuttle driver will at this moment be pushing the shuttle frame round

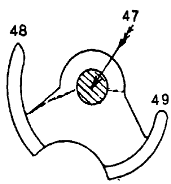


Fig. 251.

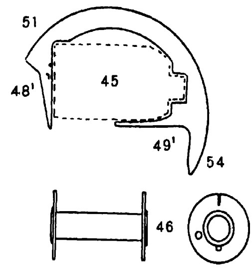


Fig. 252.

clockwise, Fig. 253, and simultaneously with this movement the needle rises. In Fig. 254, which is a plan of Fig. 253 minus the shuttle 45, the point 54 is shown behind the needle 10 and in the loop formed by the thread 22 and the needle.

In Fig. 255 the needle is nearly at its highest point, and the shuttle 45

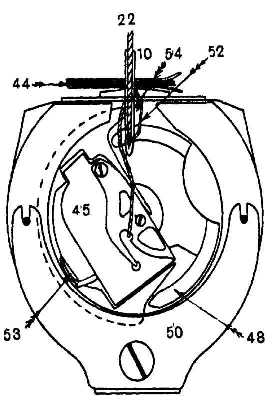


Fig. 253.

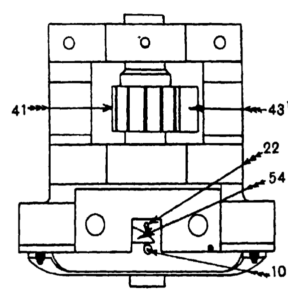


Fig. 254.

is approaching the extent of its travel clockwise. In this view the needle thread 22 is shown with the loop much enlarged—the thread take-up lever having let off sufficient to allow the body of the shuttle to pass through and to carry its own thread 52 with it.

In Fig. 256 the shuttle has arrived at the end of its journey, the needle is full up, and the thread take-up lever is drawing the slack of thread 22

with it; this operation causes the large loop to slip over the back of the

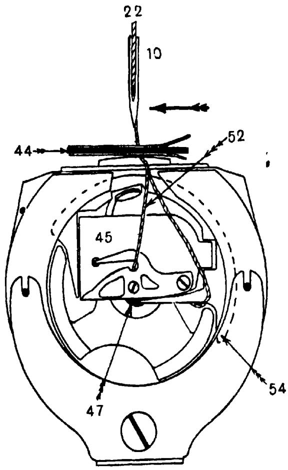


FIG. 255.

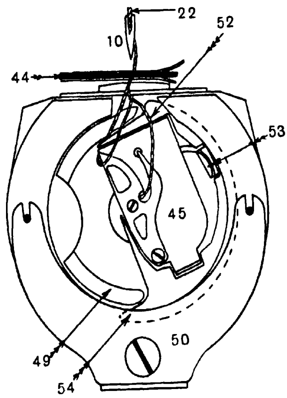


FIG. 256.

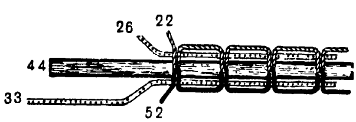


FIG. 257.

shuttle somewhat as indicated. The thread 22 has to be drawn sufficiently tight to enable it to occupy a position near the middle of the card—that is, midway between the top and bottom tapes. The feed dog starts and completes its motion just before the needle enters the cloth to repeat the cycle of operations.

Fig. 257 is an enlarged view of the tapes, card, and sewing threads, with a more or less diagrammatic view of how the two threads should appear when the stitching is completed. The upper view in Fig. 258 shows the presser foot 31 and the needle plate 37, together with an enlarged view of the needle 10, the card 44, and the two tapes 26 and 33. The lower view is a plan of part of the needle plate 37, and this shows clearly how the lower tape 33 is threaded in the slots of the needle plate.

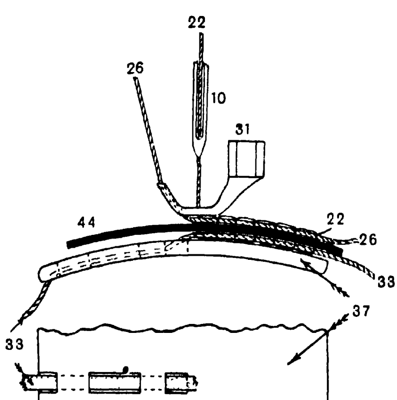


FIG. 258.

Returning now to Figs. 238 and 242, it will be seen that a crossed round belt 55, on the grooved wheel 21, communicates the rotary motion to the double-grooved pulley 56 on the stud 56^1, while a similar round belt 57 passes from the larger groove of wheel 56 to the pulley 58 of the spool, and through this to the spool-winding mechanism.

Several views of the spool-winding mechanism, which are shown about $\frac{3}{5}$ths of their actual size, are illustrated in Figs. 259 to 266. Fig. 259 is an elevation of the driving end; Fig. 260 is an elevation of the front of the winder; Fig. 261 is an elevation of the opposite end to the driving end; Figs. 262, 263, and 264 are elevations to illustrate the automatic knock-off motion; Figs. 265 and 266 are plans.

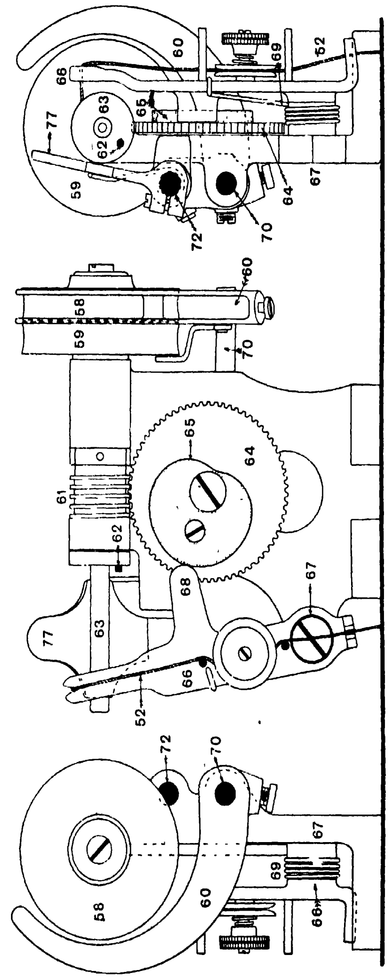


FIG. 261.

FIG. 260.

FIG. 259.

The round belt 37, Fig. 242, when inoperative, is naturally on the loose pulley 58, Figs. 259 to 266, but may be pushed on to the fast pulley 59, when desired, by means of the belt fork 60, and this may be done while the stitching machine is in operation. The belt fork is opposite the loose pulley in Figs. 260, 263, and 266, and opposite the fast pulley in Figs. 262 and 265. The shaft of the two pulleys is provided with a worm 61, a pin 62 for rotating the spool, and a spool spindle 63. Hence, when the belt is pushed on to the fast pulley as shown in Figs. 262 and 265, the spindle 63 and the spool 51 will be rotated. At the same time the worm 61, Fig. 260, will move the worm-wheel 64 slowly round, and also the heart-shaped cam 65, which is secured to the wheel 64, as shown.

The yarn guide 66 is fulcrumed at 67, while the projecting arm 68 is kept in contact with the heart-shaped cam 65 by a spiral spring 69, Fig. 260. The sewing thread 52, exaggerated in thickness, will thus be carried

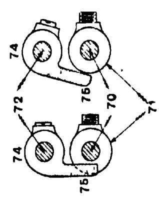


FIG. 264.

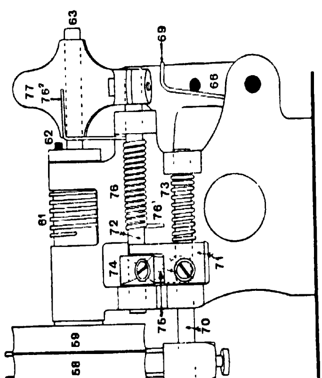


FIG. 263.

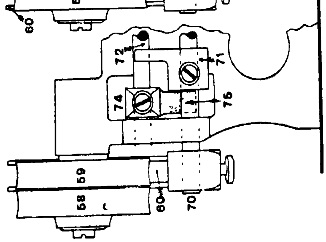


FIG 262.

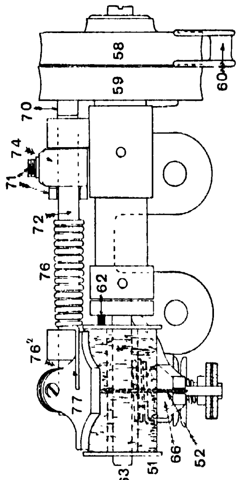


FIG. 266.

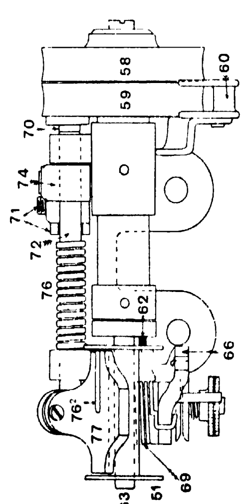


FIG. 265.

slowly and at a uniform speed backwards and forwards, between the two flanges of the spool 51, Figs. 265 and 266. This work is done, as already mentioned, during the time that the cards are being stitched by the machine proper. All the attendant has to do is to see that there are cards on the

pegs of the wheel M, Fig. 242, place an empty spool on the spindle 63, Figs. 259 to 266, and start the winding apparatus by pushing the belt fork 60 in the proper direction; the apparatus is stopped automatically when the spool is filled. This will be understood by consulting Figs. 262 to 266. Fixed to the belt fork rod 70 is a bracket 71, the projecting arm of which is forked, as shown in Figs. 265 and 266, to receive the stop-rod 72—the forked end of bracket 71 is omitted in Fig. 264. A spiral spring 73 encircles the rod 70, and this spring will clearly be compressed when the belt fork 60 and its rod 70 are pushed to the right in Fig. 262, or to the left in Fig. 265; the spring is of course not visible in the latter view, since it occupies a position under the spring 76.

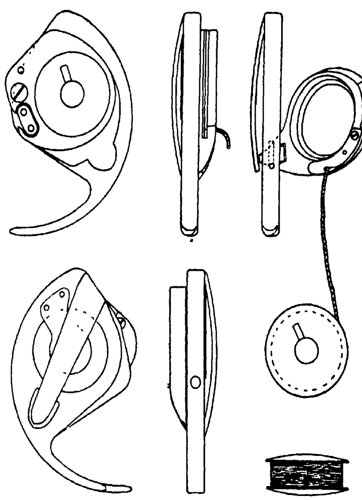


Fig. 267.

A further bracket 74 is secured to the rod 72, and this bracket has an arm 75, stippled in Figs. 262 and 264, which depends as shown. Around the rod 72 is the above-mentioned spring 76, but this spring is arranged not to be compressed, but to cause a partial rotation of the rod 72 when the spool is full.

It will be seen in Fig. 263 that one end of the spring is against the framework at 76^1, while the other end 76^2 is behind the feeler 77, and the force of the spring tends to keep the feeler 77 in close contact with the empty spool 51, Fig. 265, and also with the partially filled spool. When the belt fork 60 and its rod 70 are pushed to the right in Fig. 262, or to the left in Fig. 265, the projecting arm 75 slips, or is, rather, forced, in front of the boss 71 (see Figs. 262 and 264), and thus keeps the belt fork in the on position. As layer upon layer of sewing thread 52 is wound upon the spool 51, the feeler 77 is forced outwards gradually, but very slowly. Ultimately, when the spool is full, as in Fig. 266, the feeler 77 is full out, and the rod 72 will thus have been partially rotated until the arm 75 (see the right-hand view in Fig. 264) is clear of the bracket 71. When this happens it is obvious that the spring 73 will exert its potential energy on the bracket 71, and will force it, and also the belt fork 60, to the off position, as exemplified in Figs. 263 and 266. Again, the mechanism

being very small—see the complete apparatus in Figs. 238 and 242 as compared with the machine—it is necessary to set the automatic motion carefully, and when thus set it performs its work in an elegant manner.

Fig. 267 illustrates several views of a different kind of shuttle frame, shuttle, and spool—a type which although not modern is still in use in a number of jacquard card-stitching machines.

A few of the desirable conditions in connection with cards and card lacing are enumerated in Table X.

TABLE X.

1. A quick method of lacing.
2. Level, strong, and comparatively inelastic lacing material, and for machine lacing, freedom from knots or thick places.
3. Substantial cards capable of withstanding the drag, and the usual wear and tear which obtains while the cards are in operation on the loom.
4. Cards which are capable of resisting changes of shape and size under various atmospheric conditions.
5. Facilities for introducing new cards into the chain to replace broken ones from any cause.
6. Conditions which tend to prolong the life of the cards.
7. Lacing or stitching material which will allow each card to lie very close to the face of the cylinder when the selection of needles and hooks is taking place.
8. The prevention of card sliding near to the place where a card is removed, or where the lacing twine breaks.
9. Rapid methods of making the necessary changes for different sizes of cards, and for different numbers of stitches per card.
10. The simplest possible type of mechanism, taking into consideration the work which has to be performed.
11. Mechanism which does not easily get out of order, and in which those parts subjected to excessive work are accurately made and have wear-resisting qualities.

Some of these conditions have already been discussed; others do not come within the scope of this work. With careful work and lacing machines in good working order a set of cards may last for a considerable time, and may be in a moderately good condition when the lacing twine is worn out or ready for renewing. Some sets of cards may remain in good order for two or three renewals of lacing. In other cases the cards quickly begin to wear out, breaking near the edge, and thus causing a considerable amount of loom stoppages, with a consequent loss of production.

Fig. 268 has been prepared partly to illustrate different kinds of lacing and stitching, and partly to enable us to refer to conditions which might prove useful in cases where breaking of cards is common. The particulars referring to Fig. 268 are in Table XI.

TABLE XI.

No. 1. Face of cards for Brussels jacquard.
" 2. Back " " "
(Laced on Singer's lacing machine.)
" 3. Face of cards for 600's jacquard.
" 4. Back " " "
(Laced on Parkinson's "Rapid" machine.)
" 5. 400's cards laced on hand frame.
" 6. 600's cards with double twist between cards and no lace holes. Woodhorse and Scott's improved method.
" 7. 400's cards tape stitching. Singer's stitching machine.

Nos. 1 to 5 are laced with one black twine and one white twine, but a lens is necessary to distinguish them.

The lace holes in Nos. 3, 4, and 5—that is, in the cards for 600's and 400's jacquards—are at reasonable distances from the edges of the card, and hence these distances afford a moderate resistance to card rupture. In some cases the holes for the 600's cards, instead of being in the 2nd and 11th rows as indicated in Nos. 3 and 4, are in the 3rd and 10th rows, thus increasing the distance from the two edges, and proportionately strengthening the outer sections. In Nos. 1 and 2, however, where four lace holes are used, the outer holes are very near the edges of the card, and it is a very common occurrence for the card to break at these parts.

In Nos. 6 and 7 no lacing holes are required. No. 7 is, as stated, the stitched card, where the ordinary sewing cotton is passed through the card, and through narrow tapes, one on each side of the card, approximately every $\frac{1}{4}$ in. When the cards require to be re-sewn, and the needles pass through the same holes during the re-sewing, the cards are practically as strong as they were when sewn for the first time. If, however, through any defect, the needles enter fresh parts of the card and near the old holes, it is not unusual for the sewn portion to break off, in which case the card is useless. This defect, which was more or less pronounced when the peg wheel was under the influence of a brake, is now practically eliminated in the modern machine, where the peg-wheel, as already illustrated, is driven by a pawl and a ratchet-wheel. In No. 6 type semi-circular holes are cut out of the edge of the card, and two pairs of thin lacing twine are rotated in opposite directions to make a crossing more secure than that obtained by a single pair of lacing twines.

Each method of lacing has its own particular advantages, and also its drawbacks. It is evident, however, that there can be no sliding in the stitched cards illustrated as No. 7, and that each card can get very close to the face of the cylinder. Moreover, if a card break, it can easily be replaced by removing the stitching, making a half-twist of the two lengths

of tape, and inserting the new card between; this may be done without removing any of the undamaged cards from the loom. In some cases it may be necessary to insert a few stitches by hand. A somewhat similar method of repairing is possible when cards are laced as illustrated in No. 6,

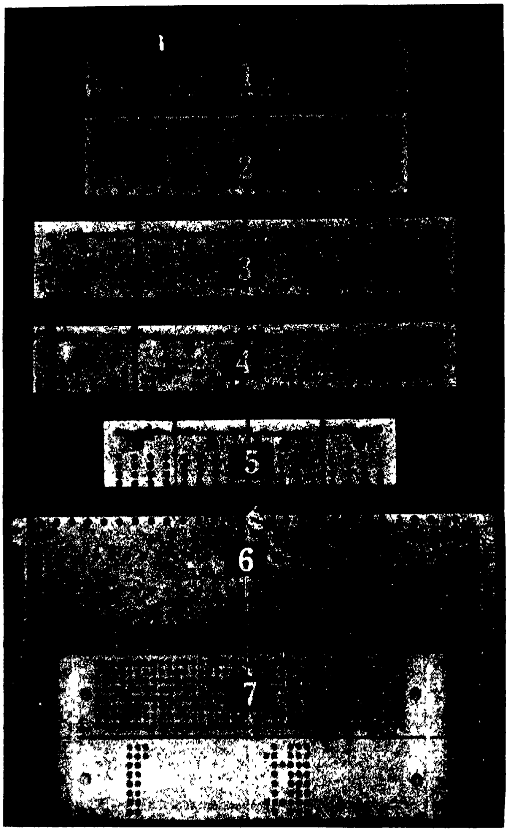


FIG. 268.

but in this, as well as in the case of all other systems of lacing, there is a tendency for the cards to slide.

The foregoing equipment of card-cutting, card-lacing, and card-stitching machinery is quite sufficient for small factories, or for those factories in which there is little concurrent duplication of the same patterns, for it is quite clear that whether the jacquard machines are of the ordinary-pitch, medium-pitch, or fine-pitch type, all the essential operations for

the preparation of the jacquard cards ready for the loom can be efficiently performed by one or other group of machines already described.

When, however, conditions arise which necessitate the employment of two or more looms on the same design, a condition which is very common in some industries, it is desirable that a further group of machines should be introduced in order that duplicate sets of cards may be prepared more quickly than is possible by the ordinary card-cutting machine. The operation of lacing or stitching the cards will still be performed at precisely the same speed as if the cards had been cut in the ordinary way on the piano card-cutting machine.

This auxiliary mechanism usually consists of two essentially different machines, termed respectively "peg-and-lace-hole machines" and "repeating machines." The former, as its name suggests, punches the holes for the pegs and for the lacing twine only, and in otherwise perfectly plain or uncut cards, in order that these cards may be laced or stitched by one or other of the methods already described preparatory to being introduced into the repeating machine where the actual holes for the pattern are punched. The girl in the foreground in Fig. 127 is lacing (stitching) a set of cards which have been prepared in a peg- and lace-hole machine ready for duplication in a repeating machine. The process of repeating may be, and is, performed by a method entirely different from that which we purpose describing at present; the method to be described first is, however, the more efficient, although the other machine possesses its own particular advantages, which will be discussed at the proper time and place.

CHAPTER XV

PEG- AND LACE-HOLE MACHINES

A LITHOGRAPHIC view of the peg- and lace-hole machine made by Messrs. Devoge and Co., Manchester, appears in Fig. 269. The machine is small, and in the illustration looks very simple, but, nevertheless, it performs the work admirably, and is an essential adjunct to the more elaborate machine by means of which the actual holes in the cards for the pattern are punched.

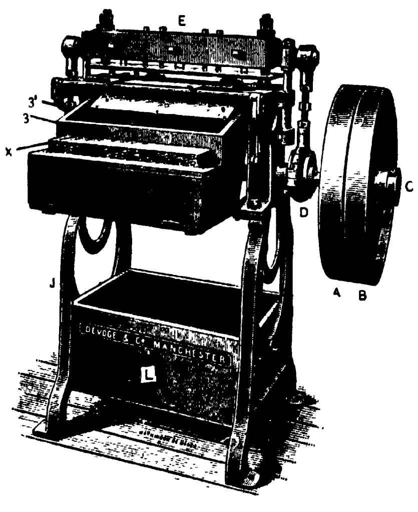


FIG. 269.

The illustration in Fig. 269 shows quite clearly the fast and loose pulleys A and B on the main shaft C, the strap of the eccentrics D, and the rod which connects the strap of the eccentric with the end of the punching block E at the top of the machine. It also shows a pile of uncut cards X on the shelf of the upper wooden box 3, a card immediately under the punches of the upper punching block E, and a punched card emerging from the machine and about to drop into the open part 3^1 of the upper wooden box. The three rows of lacing holes and the two peg holes are distinctly visible in the latter card, and the punching of these holes, as already stated, constitutes the sole function of the machine. The large box L near the floor is placed there to catch all the small circular bits which are punched out of the cards, and which drop from th corresponding punch holes in the bottom punching plate.

Fig. 270 is an elevation of the driving end of the machine, but for clearness the fast and loose pulleys have been omitted; their positions and

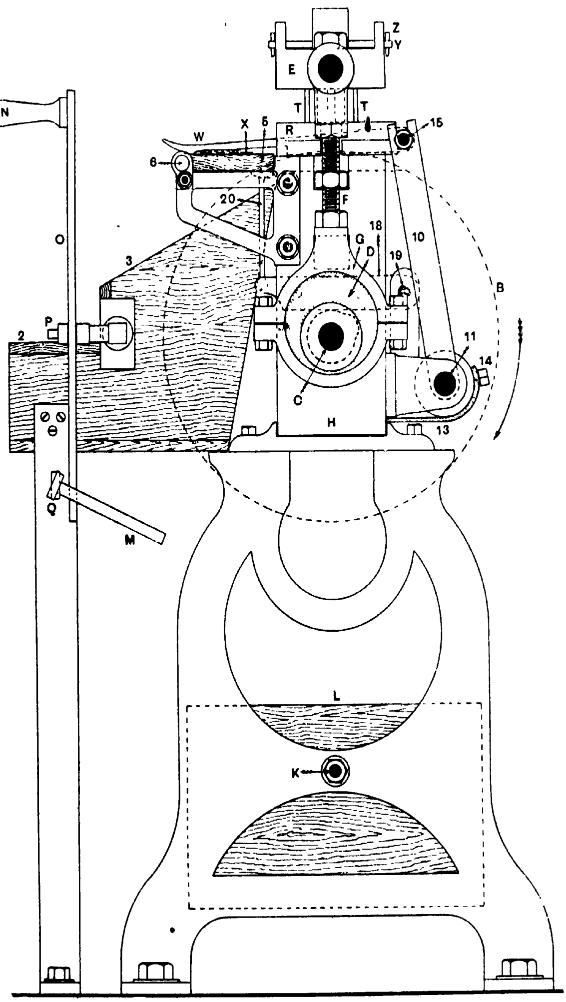


FIG. 270.

size are represented by the dotted circle marked B. A front elevation is shown in Fig. 271, while a plan view is displayed in Fig. 272. The main shaft C carries the eccentrics D, Fig. 270, one near each end, and the adjustable rods F connect the straps G of the eccentrics D to the ends of

the rising and falling block E. The upper framework H is supported by the side frames J, and the latter are joined by a rod K which passes through the box L into which the punched-out discs of the cards drop.

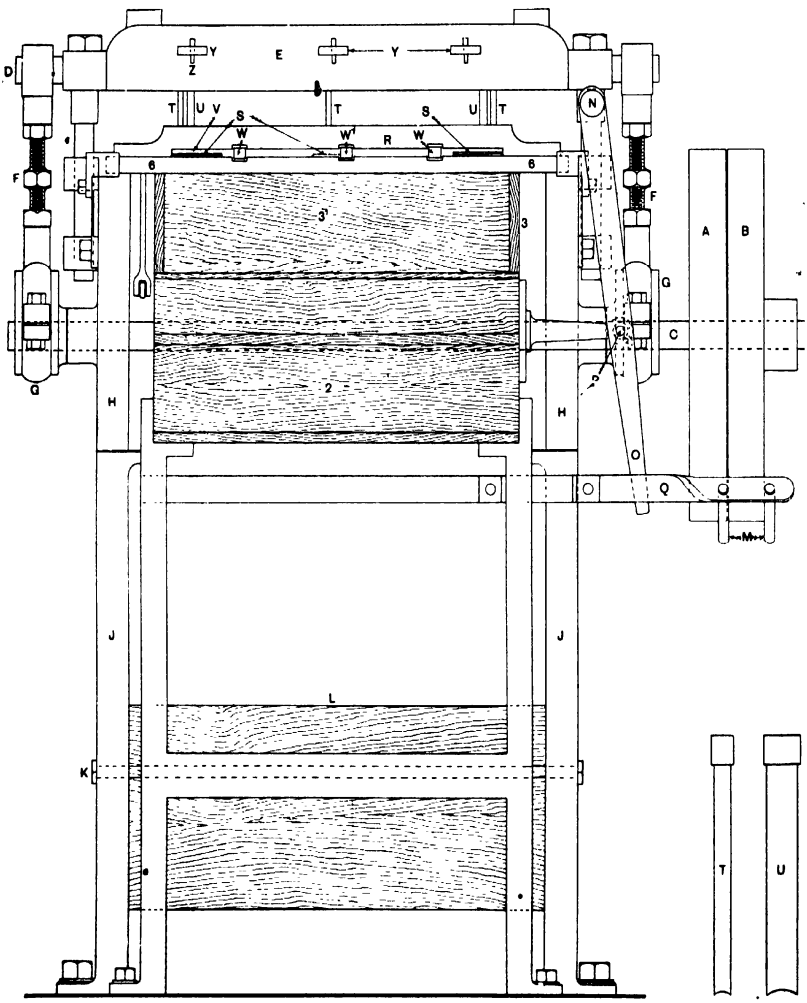


FIG. 271.

The machine illustrated in Figs. 270 to 272 is arranged to be driven from a drum on a shaft below the floor, and the belt fork M shows that the direction of movement is clockwise as indicated by the arrow in

Fig. 270. The belt fork M is operated by the handle N near the top of the lever O fulcrumed at P, the lower end of the lever passing through a slot in the sliding bracket Q to which the belt fork M is fixed as depicted in Fig. 271. The machine can, of course, be driven from above if desired, and necessary parts for this purpose are provided.

It is obvious from Figs. 270 and 271 that as the main shaft C rotates, the eccentrics D with their straps G and rods F will cause the punching block E to rise and fall every revolution; the throw or stroke of the eccentric D, and therefore of the punching block E, is $1\frac{1}{4}$ in. The actual punching plate or guide plate is composed of two fixed plates R and S; the former

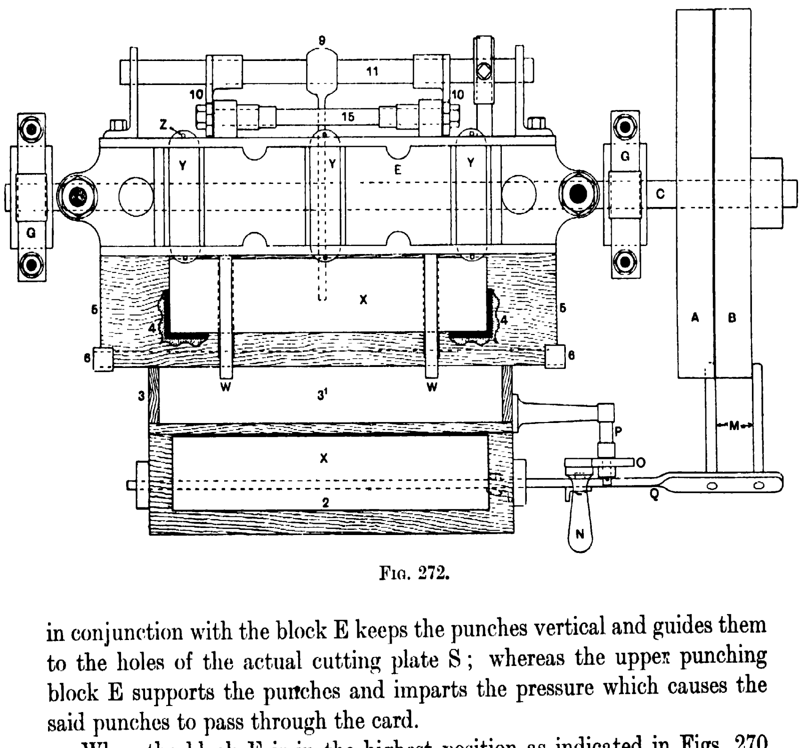


FIG. 272.

in conjunction with the block E keeps the punches vertical and guides them to the holes of the actual cutting plate S; whereas the upper punching block E supports the punches and imparts the pressure which causes the said punches to pass through the card.

When the block E is in the highest position as indicated in Figs. 270 and 271, the lower and cutting parts of the punches T for the lace holes and U for the peg holes are raised into the guide plate R and above the slot V by means of shoulders near the upper ends of the punches. This will be understood from the much-enlarged detached view of the punches in Fig. 271, and from the sectional views to follow. It is at this time that the recently punched card is ejected, and a new card inserted. The hook

W, Fig. 270, is ready to draw the card X between the two fixed guide and cutting plates R and S, and this must obviously be accomplished before the ends of the punches T and U reach the card as the block E is descending. The cross-plates Y, Figs. 271 and 272, are secured to the block E by passing their ends through slots in the block and inserting pins Z as shown, so that when the block E descends, the cross-plates Y force down all punches T and U, and effect the cutting of the eight holes as exemplified in Fig. 269. The arrangement also offers facilities for the quick removal or entry of punches before and after repairs, or to place the punches in different positions with regard to the size of card which is in work.

The stock of cards X, Figs. 269 and 272, rests upon the ledge 2 of the

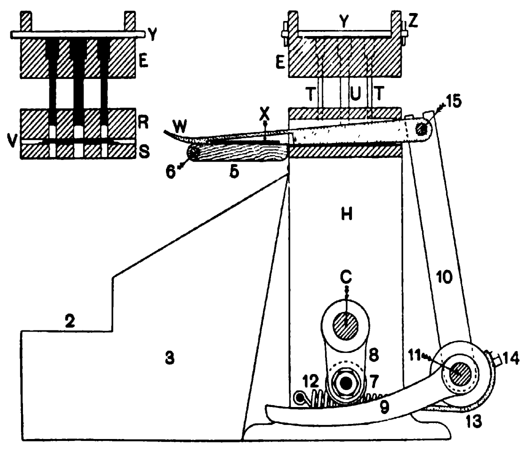


FIG. 273.

upper box 3, the opening 3^1 of the latter being left white in Fig. 272. As soon as the hooks W have drawn forward the card X, Fig. 270, under the punches T and U, the attendant takes another card from the pile and places it in position between the angular guide plates 4, Fig. 272, of the lifting board 5, fulcrumed at 6, so that the card will be as illustrated before the hooks W come forward. In Fig. 272 the hooks are forward – that is, full out, and their drawing edges overlap the outer edge of the card.

The various operations will be better understood by reference to the sectional views in Figs. 273, 274 and 275. In Fig. 273 the hook W is full out, and has been forced to this position by the action of the anti-friction bowl 7 on the end of the lever 8 fulcrumed near the middle of shaft C, and the two levers 9 and 10 fulcrumed on the shaft 11. A spring 12, one end of which is fixed to a pin projecting from a convenient part of the frame,

and the other end to a strap 13 attached by a set-screw 14 to the boss of the lever 9, serves to draw the levers 9 and 10, and therefore the hooks W, to their other extreme positions. Thus, as the shaft C and the crank 8 move clockwise in Fig. 273, the anti-friction bowl 7 gradually allows the lever 9 to be drawn upwards by the spring 12 and the connections mentioned, and therefore the catch on the hook W will draw the card X to the position indicated in Fig. 274. Small angular stop-pieces, not shown in the illustrations, are inserted at the back to arrest the card X when it has reached its proper position with regard to the punches T and U; one set of stop-pieces are used for 600's cards, and a different set for 400's cards. The front punches remain for all sizes of cards, but the peg-hole punches and

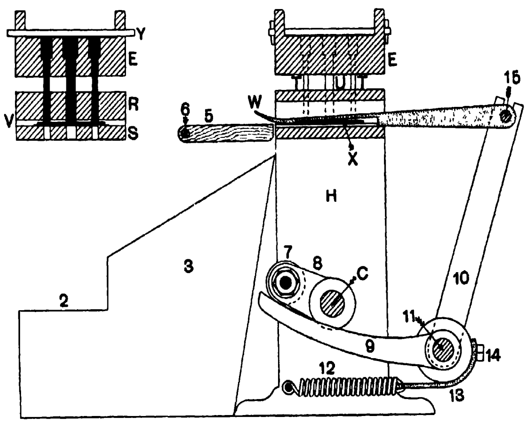


FIG. 274.

the back row of lace-hole punches are moved to suit the different widths of cards.

When it is required to punch the necessary lace and peg holes for shorter cards, say those for 8-row 200's jacquard machines, one only of the two hooks W is required, but an additional hook W^1, Fig. 271, is brought into use. The boss end of this hook is made in halves so that it may be quickly clamped on to the rod 15, Figs. 270 and 272, to which the hooks W are attached, and as quickly removed when longer cards of the 400's and 600's kinds are to be treated.

The punches T and U enter the card X immediately after the latter has been placed in position as indicated in Fig. 274 and by the sectional view on the left. It should be mentioned that the slot V into which the card is drawn is about $\frac{1}{8}$ in. deep, but the entrance is curved to about $\frac{3}{8}$ in. in order to admit of an easy and sure entrance of the card. When the

eccentric D, and therefore the block E, are full down, the punches T and U have passed through the card and have penetrated about $\frac{1}{8}$ in. into the holes in the cutting plate S. A clearing plate—that is, a plate operated by springs when the block E is rising—to remove the card from the ends of the punches T and U is illustrated in Fig. 269, but in the more modern machine this plate is unnecessary.

As the shaft C rotates, the block E is raised and the punches T and U are withdrawn from the card enclosed in the $\frac{1}{8}$ in. gap V, and when all the punches are clear, and the anti-friction bowl 7 has been rotated to the

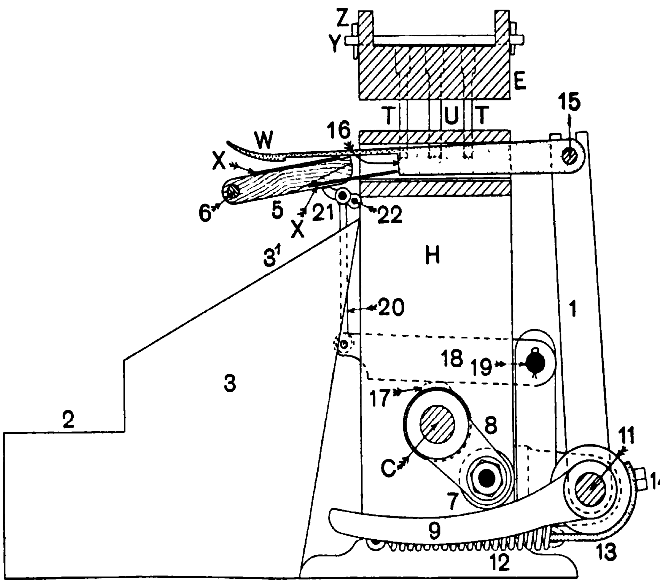


FIG. 275.

point indicated in Fig. 275, the hook W will have been forced outwards to the position shown. During this outward movement it is necessary that the newly punched card shall be ejected in order to leave room for the entrance of a new card as the hook W returns. A deep shoulder 16 on each of the two hooks W forces the card X from the gap V, and at the same time a small cam 17 on the shaft C raises the lever 18 fulcrumed at 19. The outer end of this lever is attached to the lower end of the rod 20, while the upper end of the rod is attached to the short lever 21 fulcrumed at 22. It will thus be seen that the outer end of the lever 21 will act upon the underside of the lifting board 5 fulcrumed at 6, and will raise the free end sufficiently high to form a gap through which the card X may pass and

then drop into the opening 3^1 of the box 3. The underside of the lifting board 5 is cut away to facilitate this action.

Without stating the actual times when the various actions take place, we may indicate them generally as follows: Just before the eccentric D reaches the top centre, the hooks W have slipped over the card on the top of the lifting board 5. Then the lifting board drops to its lowest position, and the hooks W commence to move in, drawing the card X with them. The eccentric causes the block E to move down when the card has travelled about $1\frac{1}{2}$ in. When the card is full in — *i.e.* under the punches T and U with the hooks W full in—the upper block E is about $\frac{1}{4}$ in. from the lowest position. The eccentric is on the front centre when the lifting board 5 commences to rise, and shortly after the edge of the lifting board raises the hooks, and the latter commence to move outwards and to eject the newly punched card as described.

Another efficient peg- and lace-hole machine is that illustrated in Figs. 276 to 283. This machine was made originally by Messrs. William Ayrton and Co., Gorebrook Ironworks, Manchester, but it is now made by some other firm. A lithographic reproduction which illustrates the general appearance of the machine appears in Fig. 276. This view represents the feed side and the balance-wheel end of the machine; the cards which are ready to be fed are shown on the wooden tray at the top of the framework and the upper plate, while those which have been punched and delivered from the machine are at the delivery side. The opening between two of the upper arms of the balance-wheel enables one to see the ends of the cards.

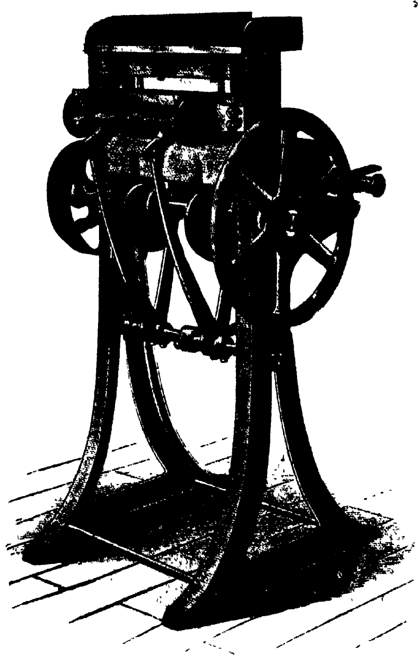


FIG. 276.

This general view might be consulted with the description of the line

drawings, of which Fig. 277 is an elevation of the driving end, Fig. 278 is a front elevation of the feed side, and Fig. 279 is a plan. The machine may be driven either by hand or by power; the illustrations show the power-driven one, in which the fast and loose pulleys A and B are on the

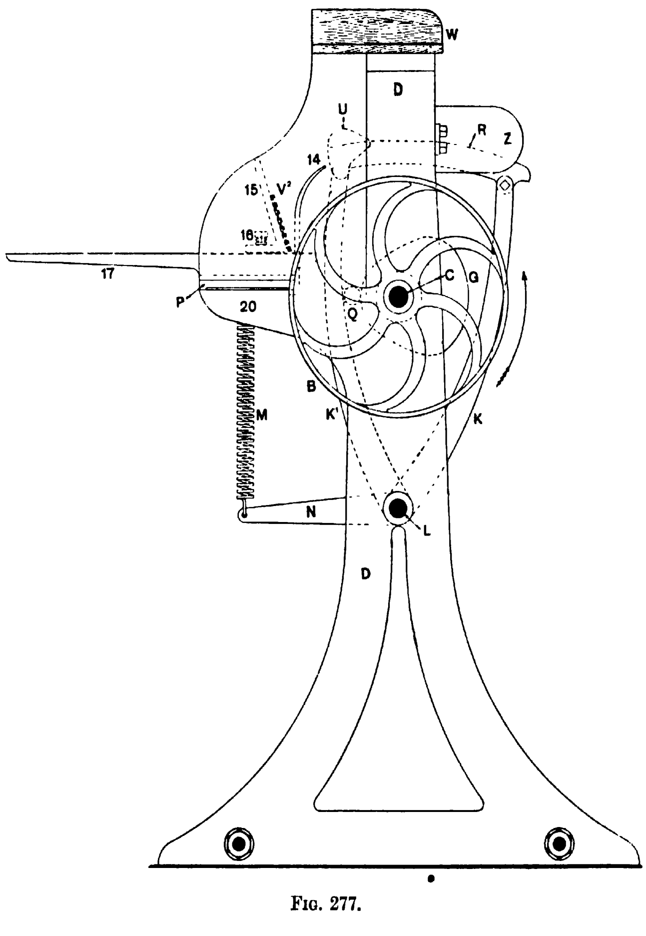


FIG. 277.

main shaft C. The latter extends through the machine, is supported in the usual manner by the two side frames D, and carries a balance- or hand-wheel E at the end opposite to the driving end. Between the two side frames D, and fixed to the main shaft C, are two eccentrics F, Fig. 278, and two cams G. The two eccentrics F, Figs. 278 and 282, raise the punching block H through the medium of two anti-friction wheels J,

and restrain its downward movement, while the two cams G operate in one direction the card-carrier arms K and K^1, both of which are fulcrumed on the low shaft L. A spring M, one end attached to the free extremity of rod N, fulcrumed on L, and the other end to a web O (also shown in Fig. 282) in the bracket P, serves to return the arms K and K^1 to the

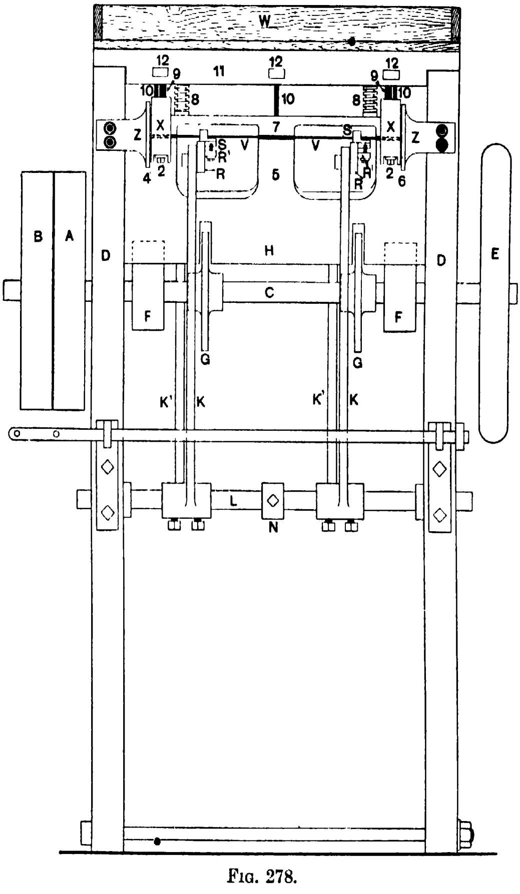


FIG. 278.

position illustrated in Fig. 277. The arm K^1 carries a wing upon the pin of which is placed an anti-friction roller Q, and it will be seen that as the shaft C rotates, the cams G will gradually force the anti-friction rollers Q —one on each arm K^1—and the two pairs of arms K and K^1 to the left in Fig. 277, and in Figs. 280 to 282. The three latter views illustrate sections of parts of the machine.

The gaps between the upper ends of the two pairs of arms K and K^1 (see also Fig. 276) are bridged by the actual card carriers R, provision being made in the latter for two cards, and somewhat as exemplified in Figs. 280 to 282. Two adjustable brackets are placed on each card carrier R, the object of these being to provide accommodation for cards of different widths, say the usual 400's, 500's and 600's jacquard cards. These adjustable guides S are shown diagrammatically in Figs. 280 to 282, but the method of adjustment is shown only in one of each pair in the plan view, Fig. 279. The lock-nuts and screw T, in conjunction with the lug R^1 on the card carrier R, and similar parts a little farther on the latter, but not illustrated in the figure, enable the attendant to move the guides S on the same card carrier R nearer to or farther from each other, and thus accommodate cards of various widths. On the upper end of each arm K^1 is a plate U, Fig. 277, the upper end of which projects above the surface of the card carrier R as shown.

The cards V, as already mentioned, are placed in the wooden tray W, Fig. 278, on the top of the machine with the numbers of the cards on the left-hand side of the card. In many cases the numbering is left until the lacing operation, or at least until the peg- and lace-holes have been cut; when this is adopted—and it is probably the best way for many reasons—it is a common practice to apply a strip of paint on the long edges of the cards and near to the end which will ultimately receive the numbers, so that the correct position of the cards will be maintained during the operation of lacing. An extra punch in the machine to cut a recess near the end of each card, or a small bit removed when the cards are being made, will answer the same purpose.

As the operation of punching proceeds, the cards are taken singly and successively from the pile and placed with the ends of the card resting on the bases of the two fixed guides X, and the middle of the card resting on the support Y, Figs. 278 and 279. The two guides Z, which are fixed to the two side frames D as shown, fix the lateral position of the card. The fixed guides X are provided with adjustable parts for different widths of cards, and when these parts are placed in their proper positions they are secured there by the set-screws 2, Fig. 278.

The card may be placed in the fixed guides X and Z, Fig. 278, at any convenient time, but it is usually placed there when the arms K and K^1 are in or nearing the extreme right-hand position, Figs. 277, 278, 279, 281 and 282. If the card is entered when the arms K and K^1 are on the extreme right, it will drop into both the fixed guides X, and into the guide 3 of the card carrier R; but if it is entered before this time it will drop only into the fixed guides X, and as the arms K approach the extreme outward position, the inclined portion of the guides S will slip under the

card, and ultimately allow the latter to drop over the inner edge of the guide S and into its correct position in the guide 3.

During the time that the shaft C and the cam G move from the position illustrated in Fig. 281 to that in Fig. 280, the arms K and K^1 and the card carrier R will move from the extreme right-hand position to the extreme left-hand position. And just before this movement is completed the eccentrics F, Figs. 278, will commence to raise the punching block H,

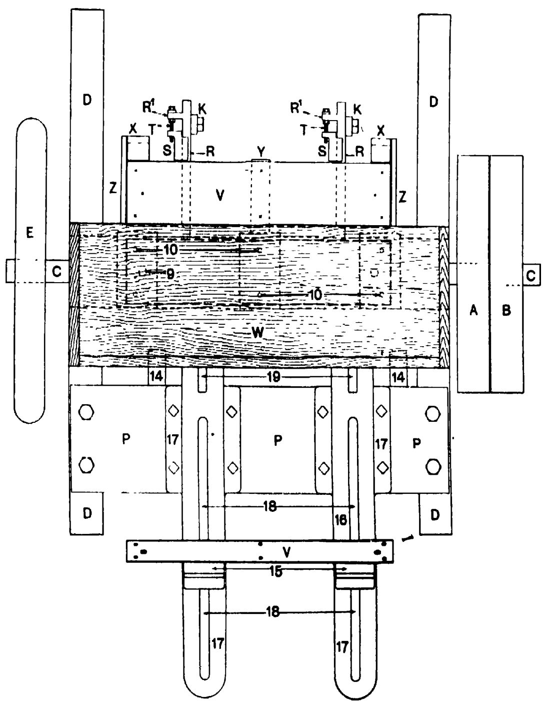


FIG. 279.

and the card in the guide 3 will then, of course, be in the position for being punched as shown in Fig. 280.

The three sections 4, 5, and 6 of the block H, Fig. 278, raise the card until the latter comes into contact with the clearing plate 7, the lower surfaces of which coincide with the upper surfaces of the three sections 4, 5, and 6 of the block H; the further upward movement of the block H carries the clearing plate 7 with it, and the latter therefore compresses the two springs 8 which encircle the pins attached to the clearing plate. The card carriers R move to and fro in the gaps between 4 and 5 and

between 5 and 6. The peg-hole punches 9 and the lace-hole punches 10 have the usual-shaped heads as shown in Fig. 282, and are supported by the upper plate 11, while three bars 12 pass through slots in the plate 11 and cover the heads of the three rows of punches 9 and 10.

Now, when the block H is in the highest position all the peg- and lace-holes punches will have passed through the card V as indicated in Figs. 281 and 282, and when the block commences to descend, the card carriers R will have moved back to the original position indicated also in Fig. 281, with the card V immediately over the inner guide 13. At a certain time—indicated in a table to follow—the punching block H shows

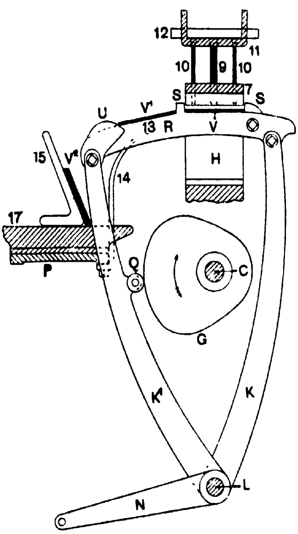


FIG. 280.

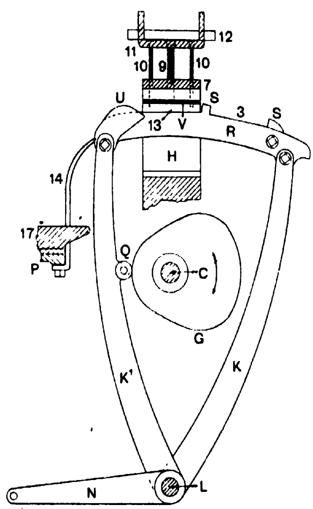


FIG. 281.

a tendency to leave the clearing plate 7; at this time, or immediately after, the compressed springs 8 force the clearing plate 7 downwards, and thus the latter pushes the card from the ends of the punches 9 and 10 into the inner guide 13. It is about this time that another card will be placed in the outer guide 3, after which the card carrier R will move forward again to the position indicated in Fig. 280, and there will then evidently be a card in each guide 3 and 13.

The punched card in guide 13 is removed from the guide and the carrier R in a unique yet simple manner. The operation is illustrated in Fig. 282. From what has been said it will be gathered that after the block H rises and the two cards are in the positions indicated in Fig. 280, the right-hand card will be carried upwards by the block H, and will remain on the ends

of the punches 9 and 10 until the card carrier R moves to the position shown in Fig. 281. But meanwhile it is necessary to dispose of the card marked V^1 in the inner guide 13, Fig. 280. As the arms K and K^1 and the card carrier R move to the right, the card V^1 will be taken in the same direction until the right-hand long edge of the card comes into contact with the left-hand side of the frame D. The card V^1 is then arrested, but the card carriers R, with their guides, continue their journey to the right; while this latter part of the movement is taking place, the left-hand long edge of the card ascends the slopes of the plates U, Fig. 282, until the centre of gravity of the card passes to the left of the ridge of U, when the

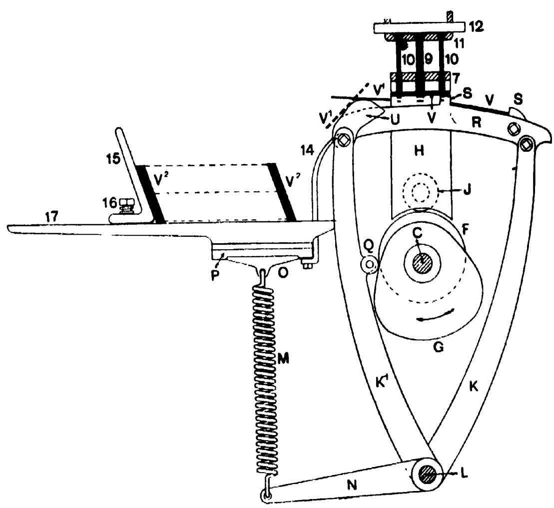


FIG. 282.

card V^1 tilts as indicated by the dotted position, and finally drops on to the curved guide 14 and against the sliding brackets 15, if this is the first card, or else joins those cards which have already been punched as indicated by V^2. These brackets 15 are held lightly in position by weak springs and bolts 16, Figs. 277 and 282, while the two plates 17 have slots 18, Fig. 279, in which the bolts 16 slide, along with the guides 15, as the cards accumulate. Each time the arms K^1 reach the extreme left-hand position they enter the slots 19, Figs. 279 and 280, lettered only in the former, and push the cards V^2 and the brackets 15 to the left and through a distance equal to the thickness of the card: the arm K^1 is shown in contact with the last card in Fig. 280. Fig. 277 shows two cards on the plates 17, Fig. 280 shows three cards, while several cards are indicated

to be in position in Fig. 282, although the first four and the last four only are drawn. The plates 17 are fixed to the plates P, Fig. 279, and the latter are in turn fixed to the projecting arms 20 of the frame D, Fig. 277.

The three plates 12 which cover the heads of the peg- and lace-hole punches 9 and 10, and the upper block 11, are reproduced in position in the plan view, Fig. 283, while detached views of the plates on a much larger scale appear in Fig. 284. Each plate has three recesses as shown, so that it is possible to cut cards for 400's, 500's, and 600's jacquards without

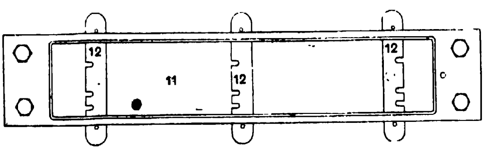


FIG. 283.

removing the punches. Thus, with four lace-hole punches in each row in the plates, and one peg-hole punch at each end, the plates would be placed so that the 2nd and 3rd lace-hole punches would be operated for 400's or 8-row cards, and while the operation of punching was proceeding, the 1st and 4th punches in each row would rise in two of the three slots and have no effect on the cards. The punches indicated by the dotted circles in the left-hand enlarged plate 12, Fig. 284, would therefore punch

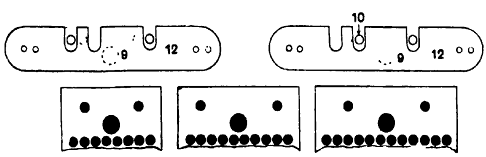


FIG. 284.

the required holes, as indicated by part of a 400's card immediately below the plate 12.

With the plate 12 in the other position on the right—that is, with lace-hole punches Nos. 2 and 3 under the slots—the punches Nos. 1 and 4, shown by dotted circles, would act on the card ; this arrangement would do for 10-row or 12-row machines—500's or 600's jacquards—as exemplified by the 10-row and 12-row cards respectively.

It will be evident that the lace-holes for the 12-row card are in the 3rd position from each end, but, as already stated, this position of the holes has a tendency to increase the life of the jacquard card. In some card-cutting rooms the plates 12 are turned through 180°, and the same lace-hole punches used for all cards ; in this case it is obvious that the

position of the lace-holes, being constant with regard to the peg-hole, would be as follows:

For 400's or 8-row cards:	the 2nd hole from each side.			
„ 500's or 10-row „	„ 3rd	„	„	
„ 600's or 12-row „	„ 4th	„	„	

The positions of the holes for the 600's cards are, if anything, then too far from the long edges of the card.

In order to supply the approximate times when the various operations take place, we might take as our starting-point in the cycle of operations that moment when the arms K and K¹ commence to move to the left in the line drawings, and to the right when viewed from the balance-wheel end illustrated in Fig. 276. We have chosen the latter view because the direction of motion is clockwise when observed from this end of the machine. The particulars appear in Table XII.

TABLE XII

At 360° or 0°: the arm K is full out at the feed side, and is just commencing to move forward with the card.
At 110°: the arm K is full in with the guide 3 of the card carrier R and the card V under the punches.
At 180°: the arm K begins to move out again.
At 270°: the arm K is full out, and remains out until 360°.

At 90°: the block H commences to rise.
At 120°: the block H reaches the clearing plate 7.
At 220°: the block H and the clearing plate 7 are in their highest positions.
At 270°: the block H and the clearing plate 7 commence to move downwards.
At 320°: the block H leaves the clearing plate 7.
At 360°: the block H is in its lowest position.

About 0°: a card V is fed into the guide 3 of the card carrier R.
At 110°: the card V is under the punches.
At 115°: the card V, moving upward with the block H, reaches the clearing plate 7.
At 200°: the holes are cut in the card V.
At 345°: the card V is forced off the end of the punches by the clearing plate 7, and drops into the guide 13 of the card carrier R.
At 345° to 360°: another card is fed into the guide 3.

At 110°: the newly inserted card has been carried under the punches in guide 3, and the first card is now in guide 13 with the long edge of the card close to the plates U.
At 200°: while the arms of K and K¹ are moving outwards, the rear edge of the card in guide 13 comes into contact with the frame or block, and the continued movement of the arms causes the front edge of the card to mount to the ridges of the plates U.
At 225°: the card is on the top of the ridge of U, and ready for tilting.
At 240°: the card drops on to the curves of the arms 15, and immediately joins those which preceded it to form the group as illustrated in Fig. 282.

It will thus be seen that in each cycle there are three cards in the machine if the cards are fed in as illustrated in Fig. 282; if they are fed in later, the back card will, of course, have joined the group on the plates 17.

A third type of peg- and lace-hole machine, also provided with a clearing plate somewhat similar to that illustrated in Fig 269, and in the machine illustrated in Figs. 276 to 284, and embodying the general type of actual punching blocks and punches, is fitted with a cylinder at the feed side and a similar cylinder at the delivery side. A series of metal cards formed into an endless chain passes over these two cylinders, and thus bridges the gap between them. The ordinary cards to be cut are fed by hand on to these metal cards at the first cylinder, and the metal cards carry the blank cards forward successively between the punching plates and under the punches where the peg- and lace-holes are cut; finally the cards are dropped from the delivery cylinder into a conveniently placed box immediately under the cylinder.

CHAPTER XVI

AUTOMATIC PEG- AND LACE-HOLE MACHINES SEPARATE AND COMBINED WITH LACING MECHANISM

FIG. 285 illustrates an automatic peg- and lace-hole machine in which the cards are stacked in a pile inside a magazine, as clearly shown. The method of driving the punching block is by means of eccentrics, and the cards are fed into the machine by suitable carriers, which select the cards singly and successively from the bottom of the pile and place them under the punches. After they are punched the cards are withdrawn from the punching blocks and deposited into another pile at the delivery side as indicated immediately behind the right-hand eccentric.

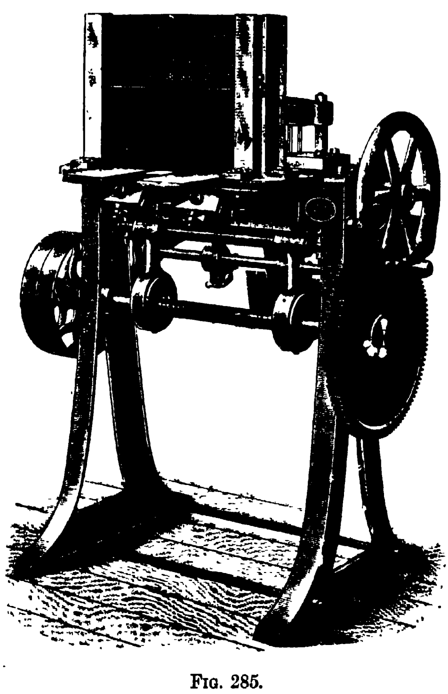


FIG. 285.

Although there may be some advantages in the automatic machine over that of the hand-fed machine, the chief advantage of an automatic peg- and lace-hole machine results when such a machine can be used successfully in conjunction with a card-lacing machine. A photographic reproduction of a combined peg- and lace-hole cutter

and lacing machine appears in Fig. 286. It is made by Messrs. John T. Hardaker, Ltd., Bowling Ironworks, Bradford, and consists of the two

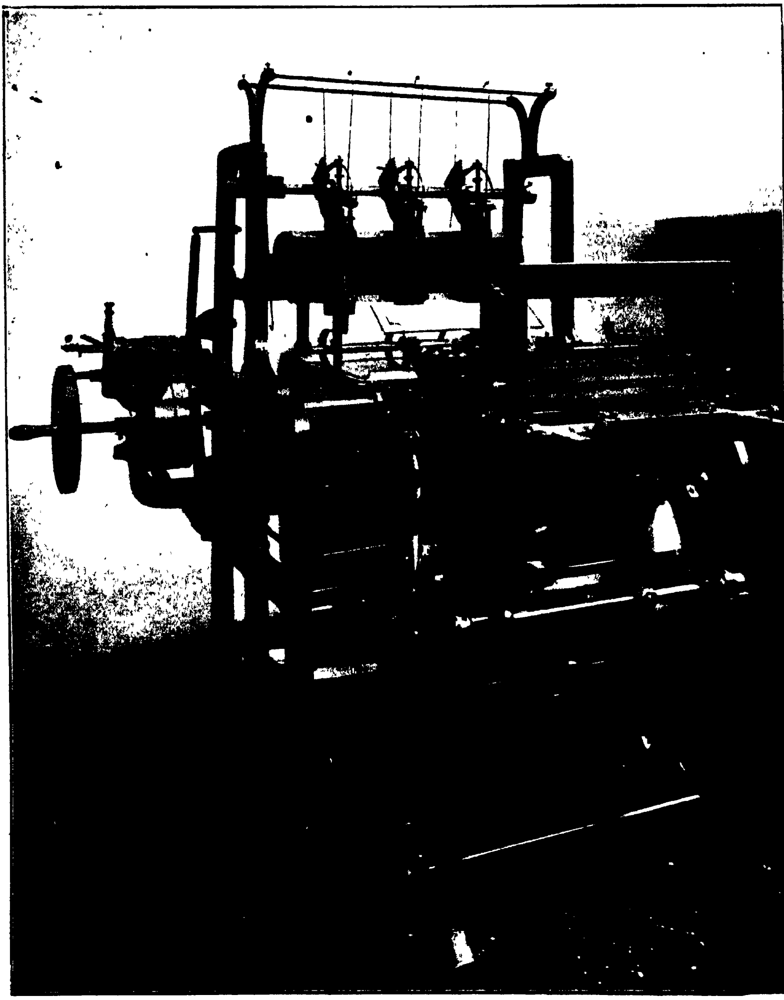


FIG. 286.

machines arranged in tandem. The peg- and lace-hole cutter is in the foreground, while the lacer, which is identical with the one already fully illustrated and described in Chapter XIII., is at the back. The view is taken from the pulley side of the lacing machine, and

hence the spool-winding apparatus for the spools of the shuttle is in view.

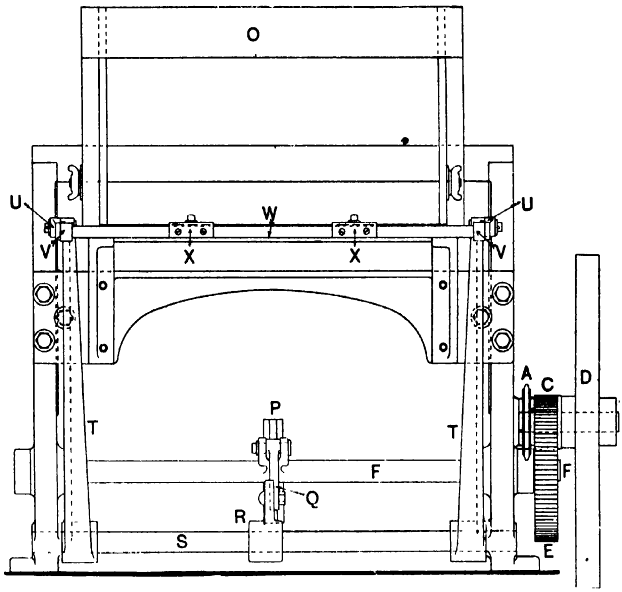


FIG. 287.

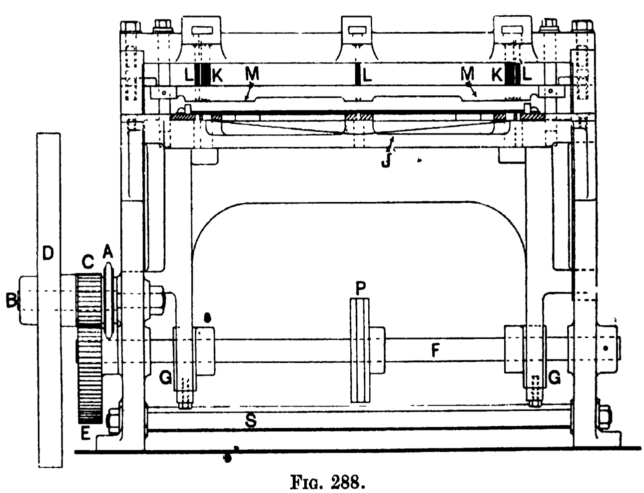


FIG. 288.

A suitable receptacle or magazine is provided for storing the cards, and a pile of cards is shown in position, the magazine being about half full.

The mechanism of the automatic peg- and lace-hole machine, and the method by means of which it is driven from the lacing machine, are displayed in the line drawings, Figs. 287 to 295.

On the cam-shaft R of the lacing machine illustrated in Figs. 215 to 236 is placed a sprocket-wheel of 60 teeth, and this wheel drives by means of a chain a sprocket-wheel of 20 teeth on a stud bolted to the framework of the automatic peg- and lace-hole cutter. This latter sprocket-wheel is

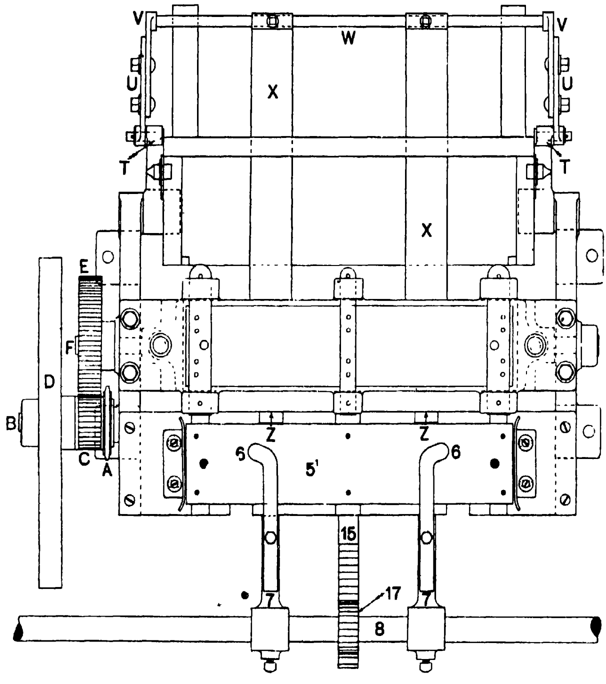


FIG. 289.

shown at A in Figs. 287, 288, and 289. The first of these three illustrations is an elevation of the feed side, the second is an elevation of the delivery side, and the third is a plan. On the same stud B which carries the sprocket-wheel A is a pinion C of 30 teeth, and a balance-wheel D. The pinion C drives a wheel E of 90 teeth on the main shaft F of the machine. In this way the automatic peg- and lace-hole cutter is driven from, and in unison with, the lacing machine.

The elevation of the balance-wheel end of the peg- and lace-hole machine is illustrated in Figs. 290 and 291, while Fig. 292 illustrates part of the

elevation of the delivery side. The method by means of which the actual punching takes place is similar to that of the machines already described; the unique feature of this machine is that of working in conjunction with the lacing machines.

On the main shaft F are two eccentrics G—one near each side frame as shown in Fig. 288. These operate on the underside and in the recessed part of forks H, Fig. 291, and through these on the lower punching block J, Fig. 288, which extends between the two forks H. The upper part of this punching block J contains three sections, as shown in the latter figure,

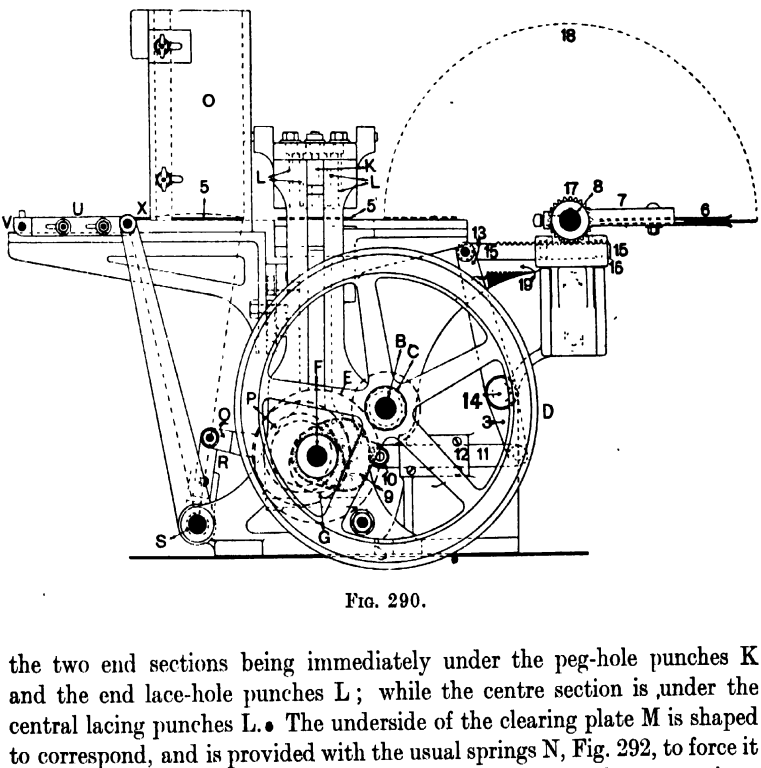


Fig. 290.

the two end sections being immediately under the peg-hole punches K and the end lace-hole punches L; while the centre section is under the central lacing punches L. The underside of the clearing plate M is shaped to correspond, and is provided with the usual springs N, Fig. 292, to force it down and to force the cards off the ends of the punches at the proper time. In Fig. 290 four lace-hole punches are shown, and their positions are also indicated in the plan view in Fig. 289. These may be arranged to operate on the cards in a method somewhat similar to that already illustrated in Figs. 283 and 284, and described in connection with the "Ayrton" machine.

The stack of cards is situated in the box O, Figs. 287 and 290, and the cards are pushed out singly and successively, and under the punches L

and K by the action of a box-cam P on the main shaft F, Fig. 290, anti-friction bowl lever Q attached to the short lever R on the shaft S, the two arms T (see Fig. 287), and subsequent connections to be described and illustrated shortly.

It will be understood that as the shaft F and box-cam P rotate, the arm Q will, through lever R, cause the shaft S to oscillate, and thus cause the two long arms T to move between the limits indicated by the dotted lines, Figs. 290 and 291. The upper ends of the levers T are connected to the brackets U—shown best in Figs. 289 and 290—and to the latter are bolted two adjustable brackets V, the ends of which support the rod W.

In connection with the further description, the sheet of details illus-

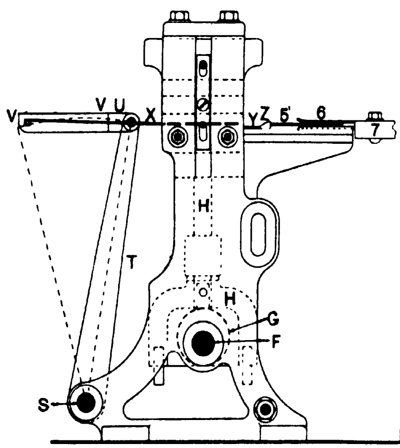


FIG. 291.

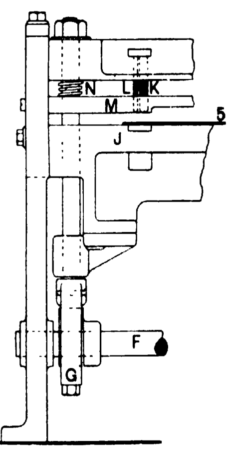


FIG. 292.

trated in Fig. 293 should be consulted along with Figs. 289, 290, 291, and 292. Set-screwed to the rod W are two plates X, the shape of each of which is indicated in the lower detached figure in Fig. 293. To the underside of each plate X is riveted a shorter spring plate Y, the end of which is fixed to a pushing plate Z, while attached to the underside of the spring plate Y is a short rod 2 so arranged that its ends 3, shown in solid black, can pass under the plates 4 in a way to be explained immediately. (A wide plate is sometimes used as suggested in the upper view in Fig. 293 and in Fig. 286.).

Let the cycle of operations start with the lever T, Fig. 290, in the full back position as indicated; then the rod W and the plate X will be in the positions shown in the lower drawing in Fig. 293, where a number of cards 5 are shown in the magazine O. For the sake of clearness we may assume

that there is a card 5^1 under the punches as depicted in the latter drawing and in Fig. 290.

When the levers T move clockwise from the balance-wheel end, it is

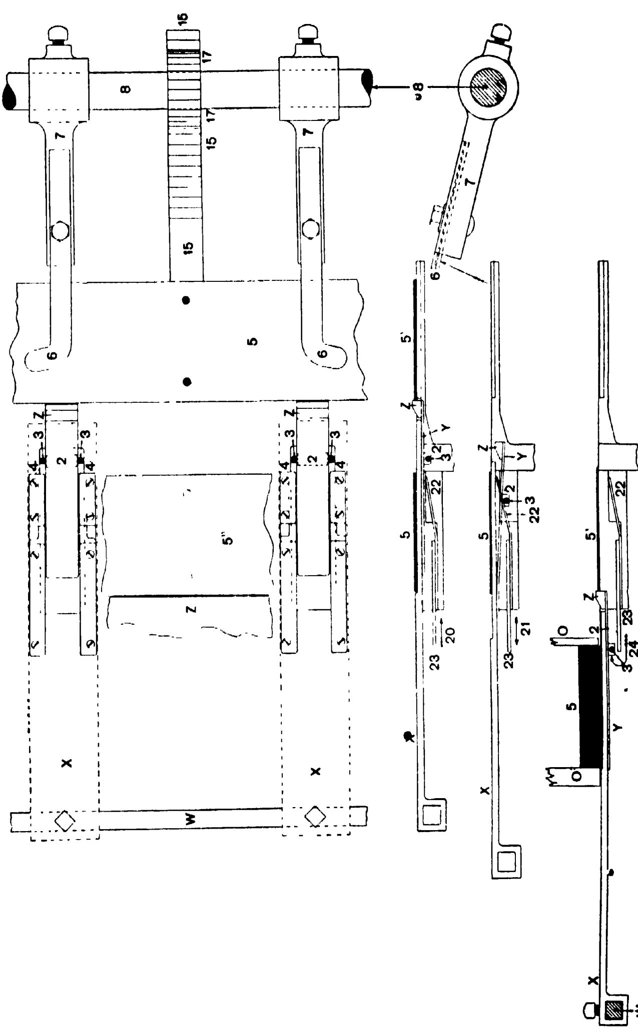


FIG. 293.

clear that the two plates X will move to the right, and in doing so, one of the cards 5 in Fig. 293 will be carried from under the pile in the magazine by the notch on plate X; at the same time, the part Z, attached to the

spring Y, will push the card 5^1 in the same direction until the two cards occupy the positions represented in the upper elevation. Then the levers T will be in the full forward position as shown in Fig. 291, the rear card will be under the punches K and L, and the front card will have been forced between the grips 6 of the card feeder 7, fulcrumed at 8, and into the dotted position in Fig. 290.

While the machine is punching the holes in the card, and the levers T and the plates X are returning to their original position, the card 5^1, Fig. 291, has to be transferred from this place to the pegs of the chains of the card-lacing machine. This operation is performed by the mechanism illustrated in Fig. 290. A cam 9, shown stippled, operates on an anti-friction roller 10, and moves the rod 11 in slide 12. The lower end of the lever 13, fulcrumed at 14, is attached to the end of rod 11, while its upper end is attached to the rack rod 15, which is capable of being moved in slide 16. The teeth of the wheel 17 on the shaft 8, and midway between the card feeders 7, are in gear with the teeth of the rack 15 ; hence, as the main shaft F rotates, the cam 9 and subsequent mechanism will cause the ends of the card feeders 7 to move in a semi-circular path 18, from the inner position—that indicated by the dotted lines of a card—to the outer position, as shown by the card feeder, while the spring 19 will cause the card feeder to return in proportion as the cam 9 presents its decreasing thickness to the anti-friction bowl 10.

It will, of course, be understood that the cam 9 must be set so that the grips 6 of the card feeder 7 will be in the position indicated in Fig. 291 just before the card 5^1 reaches the mouth of the grips 6, and that the action of the rack 15 will cause the card feeders to complete their semi-circular movement at the proper time in order that the card may be deposited safely on the pegs of the chains of the card lacer, and then be withdrawn from the grips 6 by the movement of the said chains before the return journey of the card feeders is commenced. The dwell on the thick portion of the cam is for the latter purpose.

After each card has, in succession, been pushed from under the punches K and L into the grips 6 of the card feeders 7 by the parts Z, Figs. 291 and 293, it is necessary that in the return journey of the part Z, the latter shall pass under the new card 5 which has just been placed under the punches. The method by means of which this is accomplished will be seen from the three lower figures in Fig. 293. The arrow 20 in the upper figure shows that the parts have been moving, or at present are being moved, to the right; as a matter of fact, the plan view immediately above shows that the forward movement is complete because the card 5^1 is in the grips 6. In the middle figure of the three elevations the grips 6, cut short, and the card feeder are moving clockwise, and the plate X with its complement is

moving backwards, as indicated by the arrow 21. Soon after these parts commence to move backwards, the ends 3 of parts 2 are compelled to follow the path on the underside of the flat springs 22 until the ends 3 reach and pass the end of the plate 23, when the spring Y carries the pushing part Z into the active position ; the arrow 24 in the lower illustration in Fig. 293

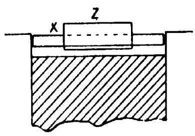


FIG. 294.

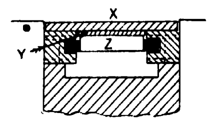


FIG. 295.

shows that this action has just been completed, and that the part Z is again in position for pushing a card from under the punches K and L into the grips 6 of the card feeders 7. Each time the parts move forward the ends 3 extend the spring 22 from the upper side in order to enable them to reach the full forward position.

Figs. 294 and 295 are sections of the parts near the active end of plate X. The former shows the end of plate X and the pusher Z when viewed from the right-hand side in Fig. 293; while Fig. 295 shows the ends 3 (Fig. 293) of the rod 2 in the race which guides them when the parts are moving to the left and underneath the new card which has just been placed under the punches of the machine.

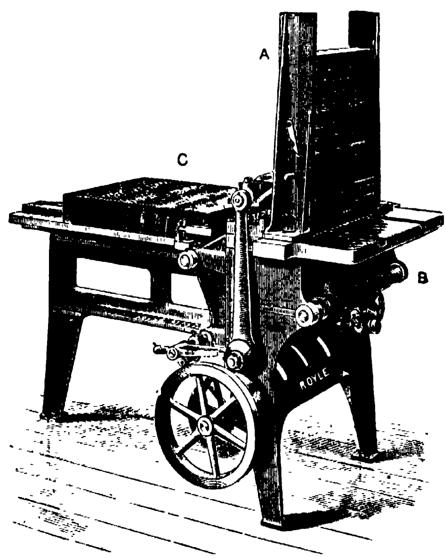


FIG. 296.

It should be mentioned that parts are made to meet the necessary requirement involved with cards of different widths.

Although it is rather difficult to obtain any particular information regarding the actual structure of machines made in other countries, and used for similar purposes, it is interesting and instructive to note the difference in appearance between foreign and home machines. The

reader, however, will know by this time the general characteristics and requirements of peg- and lace-hole machines, as well as of lacing machines, from the foregoing fully illustrated examples, and will therefore be able to form a good idea of the other less fully illustrated types which we now introduce.

An American automatic peg- and lace-hole machine is illustrated in Fig. 296. It is obviously of substantial construction, and the lower part or table support is on three legs. The cards are fed as usual between the vertical guides of the magazine A, which holds from 500 to 600 cards. A reciprocating feeder, fulcrumed on the shaft B, withdraws the bottom card from the pile and carries it to the punching blocks, where the peg- and lace-holes are cut in a very similar manner to that already illustrated and described. The card is then ejected from between the punching blocks to join those at C, which have been treated previously in precisely the same way. As in other machines for the same class of work, provision is made for both 400's and 600's cards.

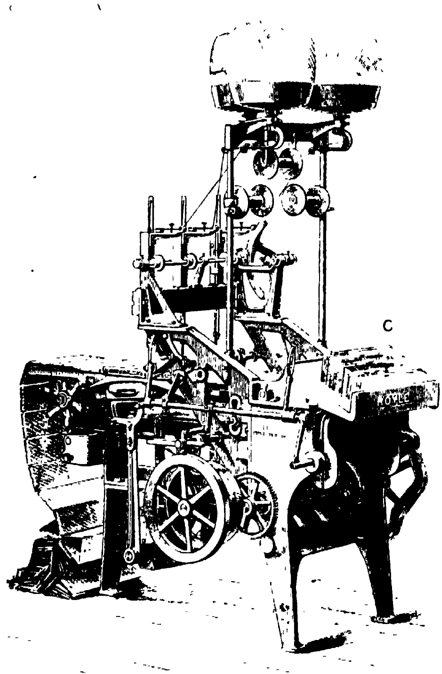


FIG. 297.

The cards C may then be taken to the inclined stand of the hand-feed lock-stitch lacer illustrated in Fig. 297, or be laced by hand. The lacing mechanism of the machine in Fig. 297 is identical with that of the automatic lock-stitch lacer illustrated in Fig. 298. The cards in the card-guide or magazine A are operated as in Fig. 296, and the peg- and lace-holes cut by very similar mechanism; but, as the title of the machine indicates, the cut cards are fed automatically, and direct connection between the cutting and lacing mechanism obtains, so that the cards may be placed mechanically on the pegs of the sprocket-chains of the lacing section. The type of lacing, and the manner in which it is performed, are of the same nature as those of the "Singer"

and "Rapid" machines, where a series of vertical needles above the cards work in conjunction with a corresponding number of reciprocating shuttles below the cards. The lacing twine comes from the balls D or from spools or bobbins, and the cards are delivered as exemplified at E.

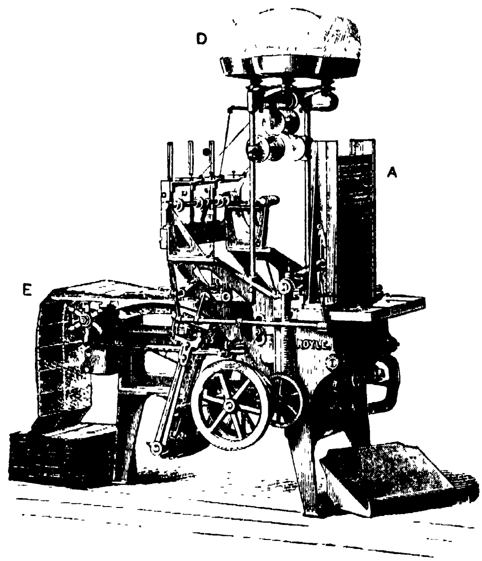


Fig. 298.

Fig. 299 illustrates an automatic peg- and lace-hole machine and a lacing machine working together, with a handy form of card truck F upon which the laced cards may be arranged as shown, and by which they may be taken to the loom. The same type of magazine A is used, but the stitching mechanism differs from the others in that the lacing is not of

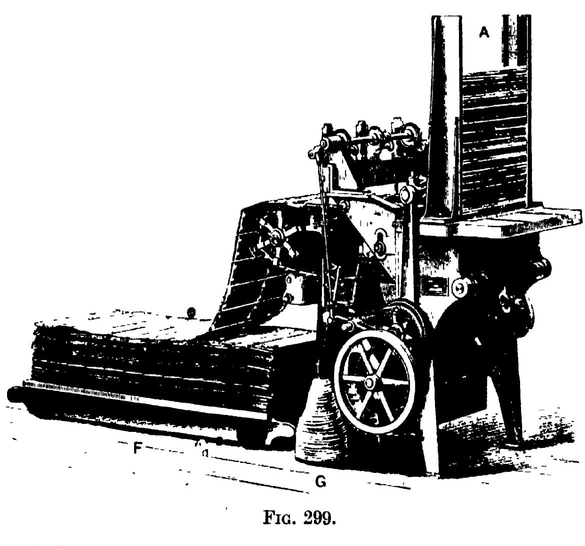


Fig. 299.

the lock-stitch type, but of the loop-stitch type. This type of stitch,

although having a tendency to ravel or run back, enables the machine to run at a higher speed than the lock-stitch type. No shuttles are required in machines with a loop-stitch, and the lacing twine in this case is supplied from the bottle-shaped bobbins G placed on the floor. It is claimed that 40 to 50 cards per minute can be fed into and laced by this machine.

The function of the peg- and lace-hole machine, as already stated, and as indicated by the name, is, first, to cut the required number of lace-holes in each card so that the necessary number of cards can be formed into a chain; and, second, to cut the peg-holes so that these may drop over the pegs of the card-repeating machine, and finally on to the pegs of the jacquard cylinder on the loom. The introduction of the peg- and lace-hole machine and the companion machine—the card repeater—is for the sake of production when two or more sets of identical cards are to be prepared for a similar number of looms engaged in weaving the same design concurrently.

CHAPTER XVII

ORDINARY-PITCH AND MEDIUM-PITCH REPEATING MACHINES

In connection with nearly all schemes of repeating mechanism for jacquard cards, it is the practice to prepare the cards with the peg-holes and lace-holes by means of some type of peg- and lace-hole machine as already demonstrated in Chapters XV and XVI. The peg-holes are utilised as guides during the cutting of the pattern holes in the repeating machine, and also serve the purpose of guiding and holding the cards in position on the cylinder of the jacquard during the operation of weaving.

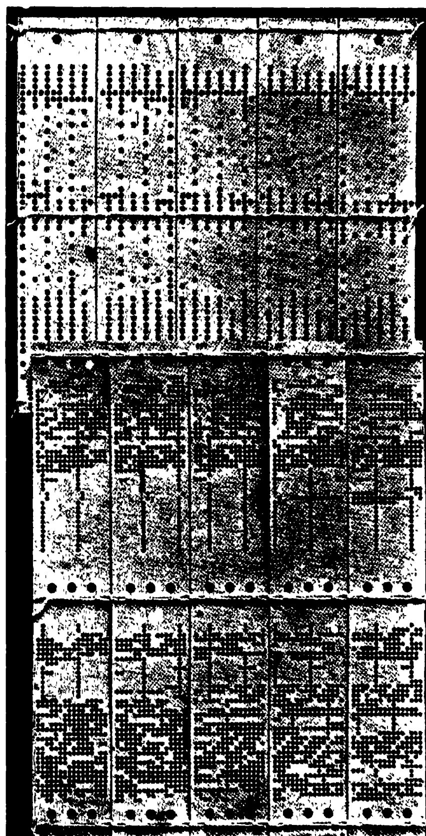


Fig. 300.

There are two peg-holes near each end of the cards used for Brussels and Wilton carpet weaving, but in nearly all other British systems there is only one peg-hole near each end of the card. In an American system, as practised by Messrs. John Royle & Sons, Paterson, N.J., two peg-holes are cut at each end of the card in the peg- and lace-hole machine; these four holes serve only as guides for the cards during

their passage through the repeating machine; a third peg-hole, however, is cut between the above-mentioned two holes, in the repeating machine, at the same time that the holes for the pattern are being cut. This middle hole is intended for use with the pegs on the jacquard card cylinder. In this way, the peg and pattern holes are made with absolute accuracy, and there is less danger of the peg-hole being damaged in the repeating machine than there is by the usual method. The ordinary arrangement of cards with a single peg-hole is shown in the upper part of Fig. 300, while the cards with the three peg-holes are shown in the lower part of the same illustration. The figure also illustrates two distinct types of lacing.

Whatever method of preparation is adopted, it will be understood that the cards must be numbered consecutively—if all the cards are in one set—for the guidance of the weaver and others during the operation of weaving. There are different methods adopted for inserting the numbers on the card. The numbers are often written in ink on the ends of the cards prior to the operation of lacing. At other times they are printed on the cards by a hand-operated numbering machine. A series of movable or rotatable rings of numbers are accommodated in a swivelling frame situated in the outside frame, and attached to and operated by a sliding block.

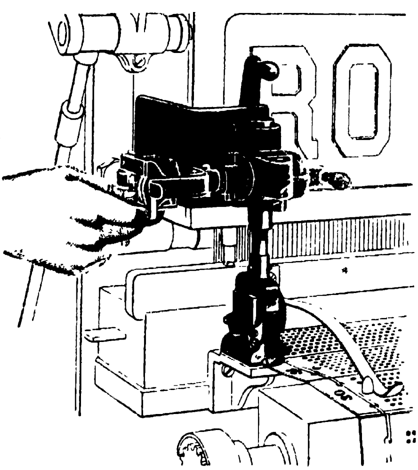


Fig. 301.

The downward pressure of the block causes the swivelling frame to move downwards and make half a revolution in order to bring the numbers in contact with the card. As the block moves upwards under spring pressure, the swivelling frame rotates back through half a revolution to place the numbers upwards and to bring them into contact with the inking pad. In the upward movement, the type for the number just impressed upon a card is replaced by the next higher number, so that the impressions may appear consecutively on the cards. The unit ring of numbers moves one division each time, while the tens and hundreds rings move proportionately.

In the American system just mentioned, a similar numbering machine is fitted to the framework of the repeating machine, as illustrated in Fig. 301. The block of the numbering machine moves automatically in unison

with the rising and falling of the repeater, and in unison with the cards as they leave the cutting blocks of the repeater. The illustration in Fig. 301 shows that cards for No. 30 and No. 31 have already been printed, and that card No. 32 will be printed next. The whole apparatus is made to swivel so that it may be moved by hand through 90 degrees with

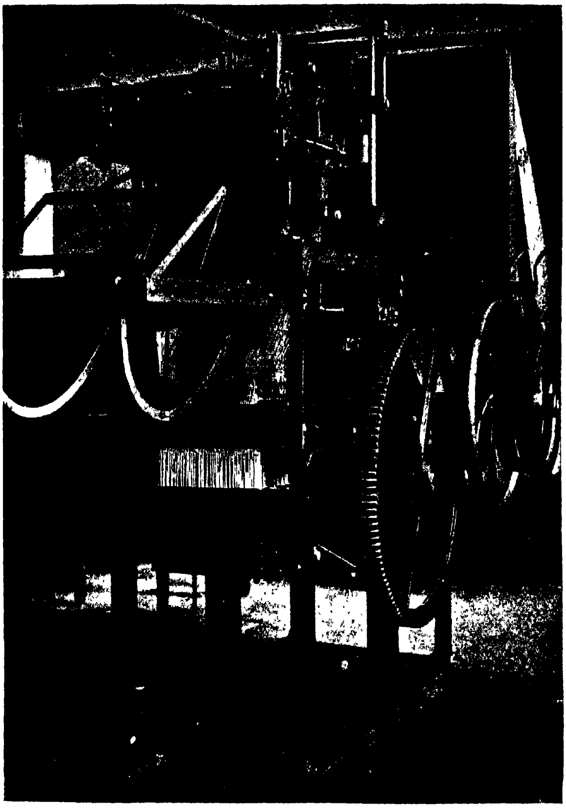


FIG. 302.

respect to the actual parts of the repeater (the faint part of the illustration); this provision is essential or desirable to enable the attendant to set it to zero when starting to repeat a new set of cards, or to adjust it to any other number if any irregularity occurs in connection with the repeating machine and the numbering apparatus. Repeating machines are made to suit the various pitches.

Coarse-Pitch Repeating Machines.—As in other types of machines, there are different makes of repeaters, each one of which possesses its own advantages, and probably its own peculiarities. The first machine which we shall illustrate is the card repeater made by Messrs. Devoge & Co., Limited, Manchester. A general view of this machine, as seen from the feed end and driving side, appears in Fig. 302. A line drawing of the pulley or driving side of the machine is illustrated in Fig. 303; Fig. 304 is a lithographic reproduction of the opposite side of the machine and the delivery end; while details of some of the mechanism appear in Fig. 305.

The machine illustrated in Fig. 302 is shown to be driven from a line shaft near the roof, and the balance- or hand-wheel C is immediately behind the fast and loose pulleys A and B. In the machine illustrated by the line drawings the drive is from an underground shaft, and the balance- or hand-wheel C is behind the spur-wheel D, but both are carried by the shaft E. The latter extends across the machine, is supported by bearings in the main side frames F, while the overhanging end at the driving side is supported by the auxiliary frame H. The spur-wheel D communicates the motion to the larger spur-wheel J, the direction of rotation of both wheels being indicated by the arrows.

The large wheel J is on the heavy main shaft K of the machine; this shaft also extends to the opposite frame, and indeed projects a little outside the frame in order that it may carry the box-cam L for the jacquard.

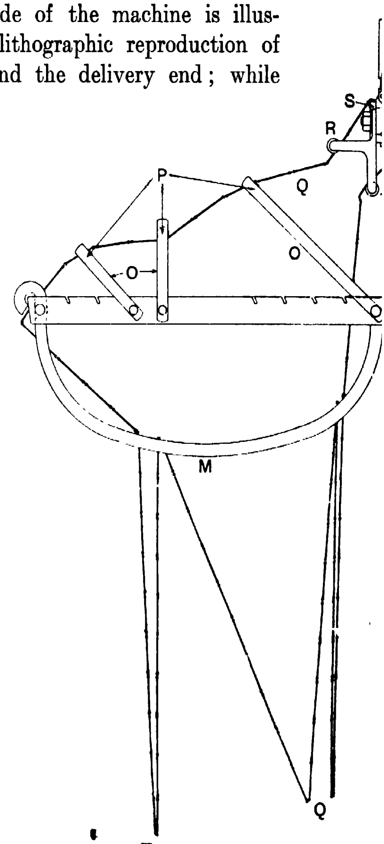


Fig. 303.

The cards which have been cut in the piano machine from the actual design, and subsequently laced by any of the methods enumerated, are first brought to the repeating machine and suspended on the card cradle M, Fig. 303. This cradle is supported by two rails N fixed to the main frames F of the repeater. Adjustable bars O serve to hold the rollers P,

and to place them in the most suitable position for guiding and tensioning the pilot chain of cards Q as they pass from the cradle M to the roller R, and thence to the cylinder S of the jacquard. As the cards leave the cylinder S in the usual manner, they pass behind the roller T, and thence direct to the card cradle M.

The action of the jacquard in general need only be described briefly, but it may be observed that the box-cam L on the shaft K,

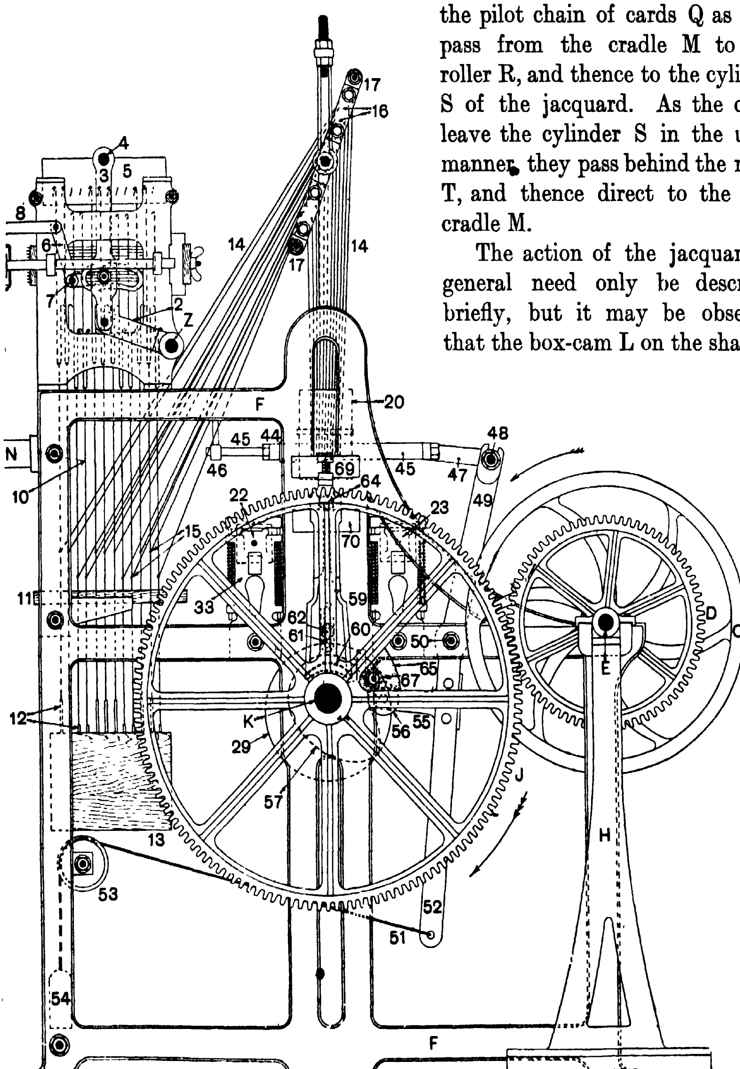


FIG. 303.

Figs. 306 and 307, operates the anti-friction bowl on the bracket U, and therefore the lever V fulcrumed at W. The connecting-rod X joins the end of the lever V to the lifting lever Y fulcrumed on the rod Z

of the jacquard. (Parts U to Y are omitted in Fig. 303 in order not to complicate the view from the driving side.) Two shorter levers 2, also fixed to rod Z, serve to raise and lower the griffe 5 as required through the medium of the pendent arm 3 and the projecting stud 4. The concentric slot in the pendent arm 3 operates the bell-crank lever 6 fulcrumed at 7; and since the upper end of this lever is attached to the bar 8, and the bar attached to the batten 9 of the cylinder S, it follows

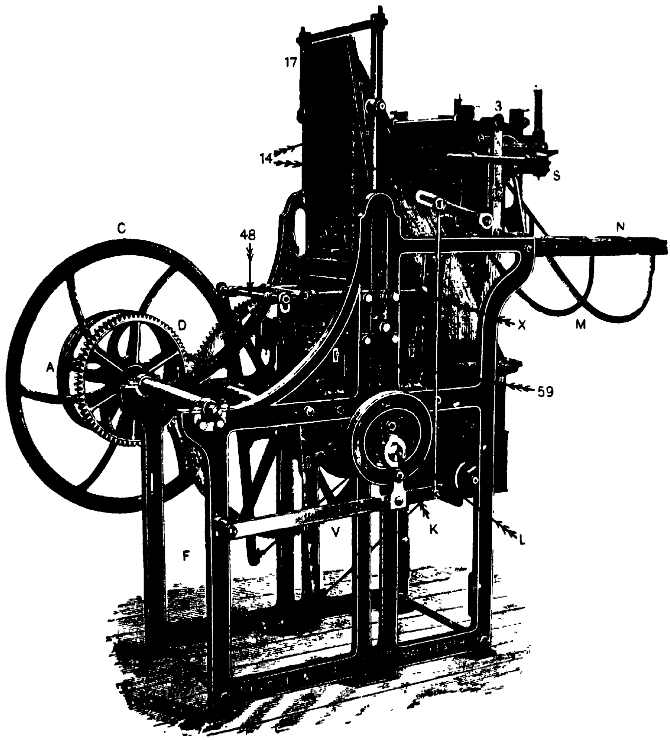


FIG. 304.

that the desired to-and-fro motion of the cylinder S will result as the box-cam L rotates.

The usual complement of 612 needles and 612 hooks is provided, and they are arranged as indicated in Figs. 303 and 306. There are 612 harness cords 10 attached to the bottom bends of the hooks, and the cords pass through a suitably drilled board 11, while their lower ends are tied to 612 lingoes 12, all of which are kept within the prescribed area by the box 13.

A further set of 612 harness cords 14, twelve only of which are shown in Figs. 303 and 306, are attached at 15 to the vertical harness cords 10. The cords 14 pass obliquely upwards to the rollers 16 of the frame 17. The rollers 16 are kept apart by the grid 18, Fig. 307, and the cords 14 pass over the top of the rollers and downwards to the punches 19; each cord has its own roller 16. All the 612 rollers are displayed in Fig. 307, but the bottom row only of 51 shows the cords passing over them and then down to the corresponding 51 punches.

Figs. 308, 309, and 310 should now be consulted in conjunction with Figs. 303 to 307. Fig. 308 is partly a sectional view of the central part of the repeater, while Figs. 309 and 310 also represent sections of the same mechanism, but the parts in these two illustrations are drawn twice the size of the corresponding parts in the remainder of the illustrations.

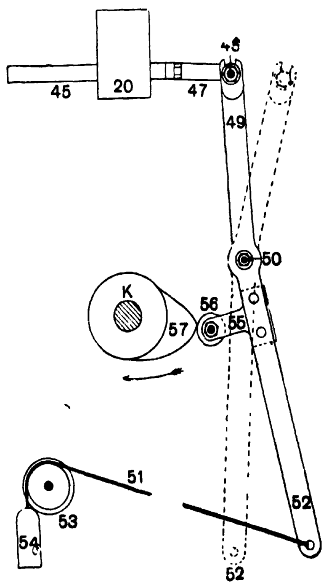


FIG. 305.

It is not difficult to see that when the box-cam L, Fig. 306, is in the position shown, the griffe 5 will be in its highest position, and the cylinder S full out as indicated there, and also in Figs. 303 and 308. It is also clear that when the box-cam L has moved half-way round, to the position indicated in Fig. 304, the griffe will be down, and the cylinder S with its card in close contact with the needle board of the jacquard. The latter position is, naturally, that in which the selection of the needles takes place according to the positions of the holes and blanks of the card. In Figs. 303, 306, and 308 it is assumed that the selection has just been made, and that subsequently half a revolution of the shaft K has been made to place the parts in the positions illustrated.

Now it is obvious that those hooks of the jacquard which are lifted will in turn have lifted the corresponding harness cords 10 and lingoes 12. This upward movement of certain cords 10 would slacken correspondingly the attached oblique cords 14; and if the weighted punches 19 were free to descend, it follows that the slackened cords 14 would permit of the downward movement of certain punches 19. The harness cords 10 in

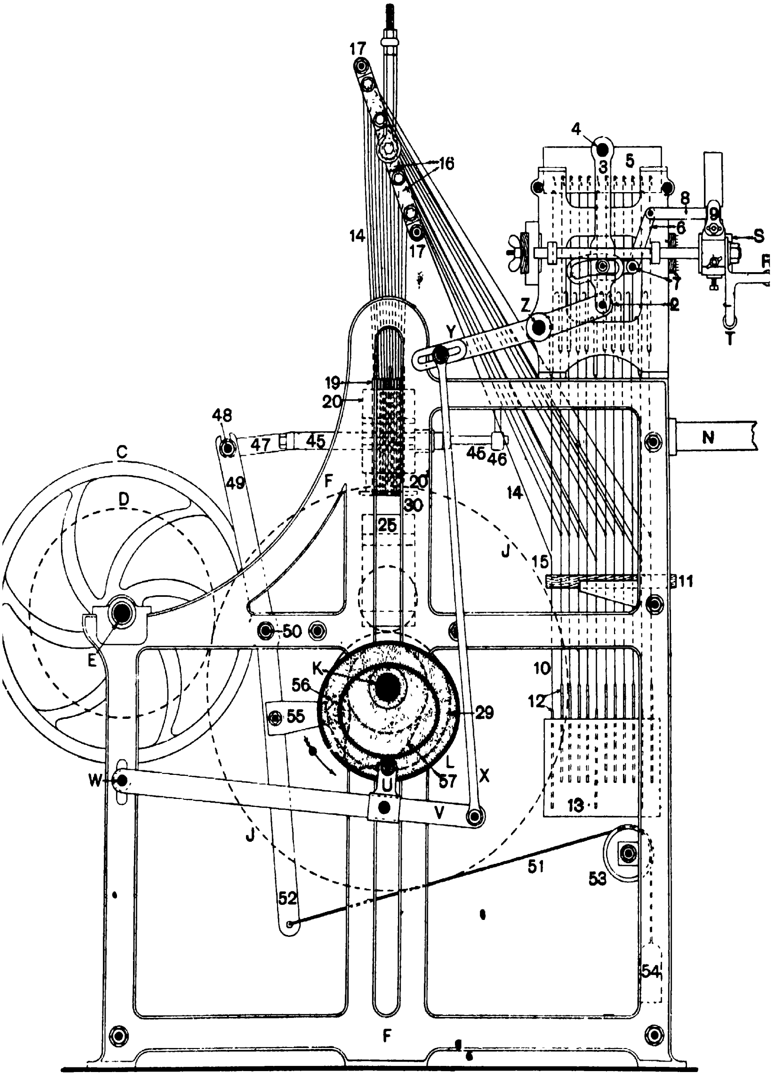

17
16
14
17
4
3
5
8
9
6
S
7
2
Z
Y
T
19
20
48
47
45
45
46
N
C
49
F
20
D
30
25
14
J
15
11
E
50
10
K
56
12
55
29
L
W
U
57
X
13
V
J
51
53
52
54
F

Fig. 306.

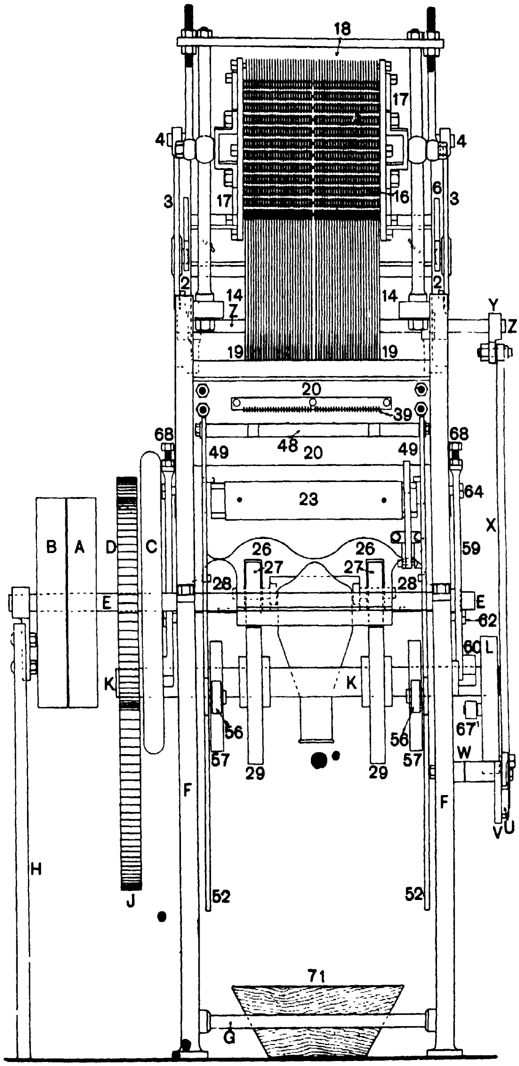

18
17
4
4
3
17
16
6
3
2
2
14
14
Z
Y
Z
19
19
20
39
68
48
20
49
49
68
23
64
X
B
A
D
C
26
26
59
27
27
28
28
E
E
62
60
L
K
K
56
56
67
57
57
W
29
29
F
F
V
U
H
52
52
J
71
G

FIG. 307.

Figs. 303, 306, and 308 may be taken to represent three distinct rows of 12, and an examination of the knots 15 will show that the orders are as shown in Table XIII.

The movements of the punches 19 will, of course, be in the opposite direction — *i.e.* downward—to those of the oblique harness cords to which they are attached: the reason for this will be explained shortly. The resulting positions of the punches 19 are shown only in Figs. 306 and 308, and in the enlarged illustration in Fig. 310.

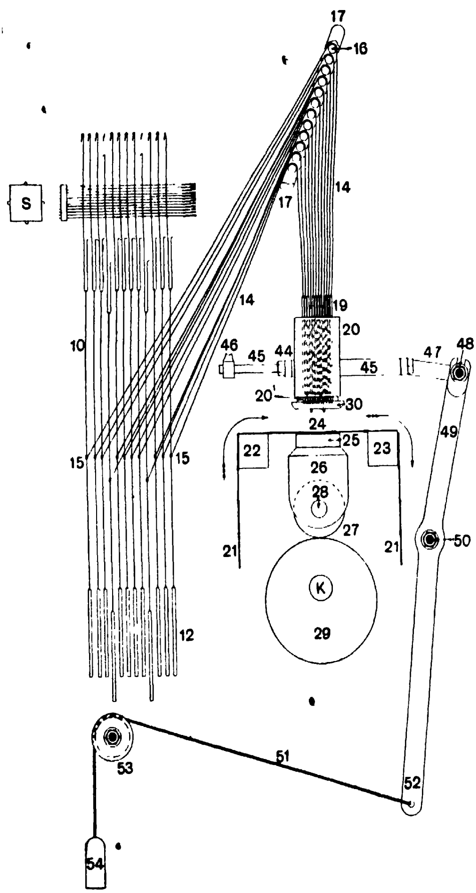


Fig. 308.

There are two conditions necessary with regard to the manipulation of the punches 19 in the punch box 20: First, there must be provision for a free vertical movement on the part of every punch 19, so that when any of the jacquard hooks are raised the corresponding punches 19 may descend with ease to their lowest position; and, second, each punch which has descended, in virtue of a rising jacquard hook, must be held securely in the new position until the operation of punching the card is completed. The method by means of which these two essential conditions are fulfilled will be described and illustrated shortly; in the meantime, we are at liberty to assume that such conditions are satisfactorily achieved by the nature and movement of the mechanism involved.

TABLE XIII.

	Hooks.	Fig. 303.	Fig. 306.	Fig. 308.
Numbers of hooks in short rows. No. 1 hook nearest the cylinder.	1	up	up	up
	2	,,	down	,,
	3	down	up	,,
	4	,,	,,	down
	5	up	,,	up
	6	,,	,,	,,
	7	,,	down	,,
	8	down	up	,,
	9	,,	,,	down
	10	up	,,	up
	11	,,	,,	,,
	12	down	down	,,

The cards containing the peg- and lace-holes only, and in a chain form, have to be punched exactly as are those marked Q in Fig. 303, which, as already stated, have been punched from the design. The cards to be duplicated, of which thirteen from the chain are shown at 21 in Fig. 308, are arranged as shown; five of the cards bridge the gap between the two repeating cylinders 22 and 23, while four are hanging down at each side, and the arrows indicate the direction which the cards follow during the operation. The middle card 24 is shown on the lower punching block 25, which is secured to the block carrier 26. Two recesses in the block carrier 26, Fig. 307, serve to accommodate two anti-friction bowls 27 which rotate on the shaft 28, Figs. 307 to 310. Two large discs 29, set eccentrically on the heavy main shaft K, impart the necessary upward movement to the anti-friction bowls 27, and therefore to the block carrier 26 and lower punching block 25; the blocks descend by gravitation.

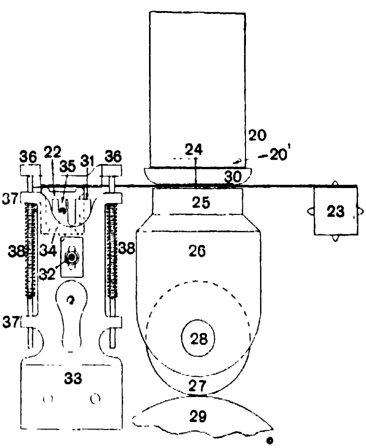


FIG. 309.

In Fig. 308 the eccentrics 29 are in the lowest position; half a revolution will enable them to raise the block carrier 26, block 25, and card 24 to the highest position. An upward movement of about $1\frac{3}{4}$ in. to 2 in. carries the card into close contact with the clearing plate 30, while a further

upward movement of ½ in. will carry the clearing plate 30 to its highest position, and at the same time will cause the brass sliding punch box 20^1 to slide ½ in. into the punch block 20 (punch box 20^1 shown more clearly later). When this movement is complete, the blocks 20^1, 26, card 24, and clearing plate 30 will be in their highest positions, as indicated in Figs. 309 and 310; and if the dropped punches 19 have remained stationary, the card 24 will have been raised above the plane of these punches, and hence holes will appear in the card opposite the ends of the depressed punches. The holes in the card 24, through which the ends of the punches 19 have entered by punching, will correspond exactly with the holes in the card which operated the needles and hooks of the jacquard.

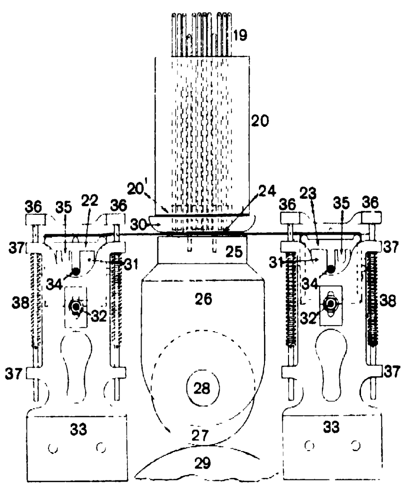


FIG. 310.

It will thus be seen that when a card from the chain Q in Fig. 303 is presented to the needles of the jacquard, all needles opposite the holes will remain undisturbed, the corresponding hooks will be raised, and simultaneously the same number and order of punches 19 will be free to descend to the lowest position; then when the block 25 is raised, all the depressed punches will pass through the cards — or, rather, the card will be forced past the ends of the punches—and hence a complete card is punched with every revolution of the main shaft K.

Before leaving Figs. 308 to 310 we might show what provision is made for repeating the two distinct widths of cards, 8-row and 12-row. In Fig. 308 there are five cards in the stretch between and including the cylinders 22 and 23; there are also five cards in the corresponding positions in Fig. 310. In both figures the cards are 12-row or 600's. In Fig. 309 there are seven cards on the stretch, and these are 8-row or 400's cards. Two cylinder supports 31, Fig. 310, are provided for each repeater cylinder 22 and 23. These supports or blocks 31 can be adjusted vertically by means of the studs 32 in the supporting brackets 33 which are fixed to the central rail of the side frame, as shown clearly in Figs. 302 and 303. When the 600's cylinders and cards are in use, the pins or studs 34 of the cylinders

are entered into the deep slots of the supports 31, as illustrated in Fig. 310; but when 400's cards have to be repeated, the studs of the cylinders are entered into the shallow slots 35, as depicted in the single cylinder support in Fig. 309; the support for the right in this figure has not been drawn.

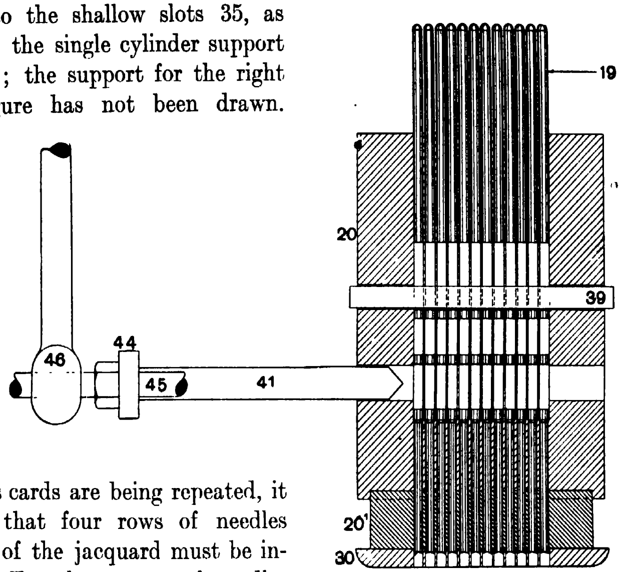


FIG. 311.

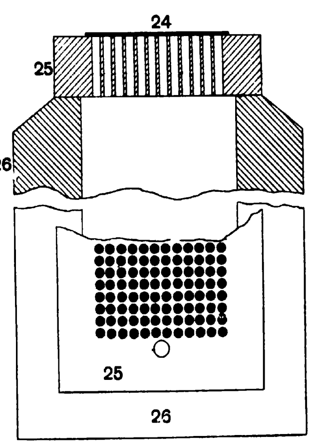


FIG. 312.

When 400's cards are being repeated, it is evident that four rows of needles and hooks of the jacquard must be inoperative. Two long rows of needles at the top of the needle board in the jacquard, and two rows at the bottom, are pressed back and held there by plates, so that the corresponding hooks will remain down and the middle eight rows be operated.

After each card has been cut, and as the block is descending, the hooks of the upright jacquard catches are caused to come into contact with the lanterns on the ends of the repeating cylinders 22 and 23, and thus the two cylinders are simultaneously turned one-quarter of a revolution so as to bring the cards successively into position under the punches 19. The repeating cylinders are not perforated on each face like the jacquard cylinders, but otherwise the structure of the two kinds is the same. The shafts of the hammers 36 of the repeating cylinders 22 and 23, Figs. 309 and 310, pass through holes in the projecting parts 37 of the

bracket 33, and spiral springs 38, with a pin through the hammer shaft, act in the usual way to prevent undue vibration on the part of the cylinders.

Figs. 311 to 316 illustrate the movements of the punches 19 and the method by which they are kept in their positions during the operation of punching. Fig. 311 is a sectional elevation of the punch blocks 20 and 20^1 and the clearing plate 30, with one short row of 12 punches in the inoperative position—that is, in the highest position when the card on the cylinder S of the jacquard is making its selection. The upper part of Fig. 312 is a sectional view of the cutting plate 25 and the two sides of the block 26; while the lower part of Fig. 312 shows a plan view of part of the cutting block 25 and part of the block 26. Fig. 313 illustrates four punches 19 out of the long row of 51 (there are really 53 punches in a long row), while Fig. 314 shows that two out of the same four punches have been lowered as already explained. (See the small squares under Figs. 313 and 314.)

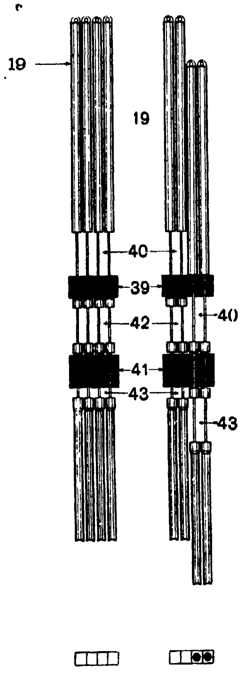


FIG. 313. FIG. 314.

It will be seen that each punch (except the extreme end ones, which are not shown) is cut away at three points and at both sides, so that the punches may be the proper pitch for cutting and still leave room between each pair of punches for the insertion of thin rectangular bars or knives. There are two sets of knives; in the upper set the 53 knives marked 39 are fixed in the block, and they pass between the punches 19 in the upper long rectangular gaps 40. The second or lower set also contains 53 knives; these are marked 41, and they are movable in order that they may enter into the rectangular gaps 43 or 42 between the punches, according as the corresponding punch is up or down.

In Fig. 311 the sliding knives 41 are full out, and quite clear of all the punches 19. This, as already indicated, is a little after the time when the selection of needles and hooks takes place, and the sliding knives 41 remain out until the jacquard griffe is raised, and, of course, until certain of the punches 19 have descended to correspond with those hooks which have been raised in virtue of holes in the jacquard card. The four small squares under the punches in Fig. 314 indicate that Nos. 1 and 2 correspond

to two blanks, while Nos. 3 and 4 correspond to two holes in the card, because the corresponding hooks in the jacquard have been lifted.

The 53 knives 41 are fixed to the rectangular bar 44, and the ends of the bar are attached to the sliding rods 45. The outer end of each rod 45 passes through a guide 46, while the inner or longer part passes through a hole in the block 20. The opposite end of each rod 45 is attached to the connecting links 47, Figs. 303, 305, and 308. A horizontal bar 48 (see Fig. 304 and Fig. 307) connects the two links 47, while the bar 48 is connected as shown to the upper arm 49 of a lever fulcrumed at 50; a cord 51 is attached to the lower arm 52 and passed over a grooved pulley 53, while a weight 54 is fixed to the cord as shown.

Fixed to the lower arm 52, Fig. 303, and a little below the fulcrum 50, is a bracket 55 carrying an anti-friction roller 56. The weight 54 keeps the roller 56 in close contact with the contour of the cam 57 fulcrumed on the main shaft K. It will thus be seen that as the main shaft K rotates, the cam 57 will, through the roller 56, cause the lower arm 52 to move out positively from the dotted to the solid position in Fig. 305, while the weight 54 will pull it back negatively as the face of the cam 57 in contact approaches the thinnest part, until ultimately the arm 52 assumes the dotted position in Fig. 305 and the solid position indicated in Fig. 303.

During these movements the upper arm 49 will reciprocate with the lower arm 52; hence, when the cam 57 has forced the arm 52 outwards to the solid position in Fig. 305, the upper arm 49 will be full in, and the sliding rods, with all connected parts, will be on the extreme left-hand position when viewed from the driving side of the machine. This is the position shown in Fig. 311, with all the knives 41 clear of the slots 42 and 43 in the punches 19, and the jacquard griffe in its highest position. But when the point of the cam 57, Fig. 305, passes the roller 56, the latter moves quickly down the steep face of the cam under the influence of the weight 54 (an action which is just completed in Fig. 303), and hence this action causes the subsequent parts to draw the knives 41, Fig. 311, to the right, in which case they would clearly enter the bottom slots 43, provided that all the punches were in similar positions to that represented by the 12 punches. In the figure none of the 12 punches would project below the face of the clearing plate 30, because the corresponding hooks of the jacquard are all down in response to the blank portion of the pilot card in the set Q, Fig. 303. The blank row in the card which has just operated the needles in the jacquard in Fig. 303 would thus have its counterpart in the corresponding row of the card 24 in Fig. 312. If, however, any of the punches happened to be down—and some would be down in other short rows of the punches—they would appear as shown by the third and fourth punches in Fig. 314, and the knives 41 would then have entered

the middle slot 42 of these punches. The knives 41 would thus prevent the punches 19 from rising when the card 24 on the punch block 25 came into contact with the ends of the dropped punches; hence, the card would be forced upwards beyond the ends of these dropped punches, and the latter would therefore pass through the card as exemplified in Fig. 315.

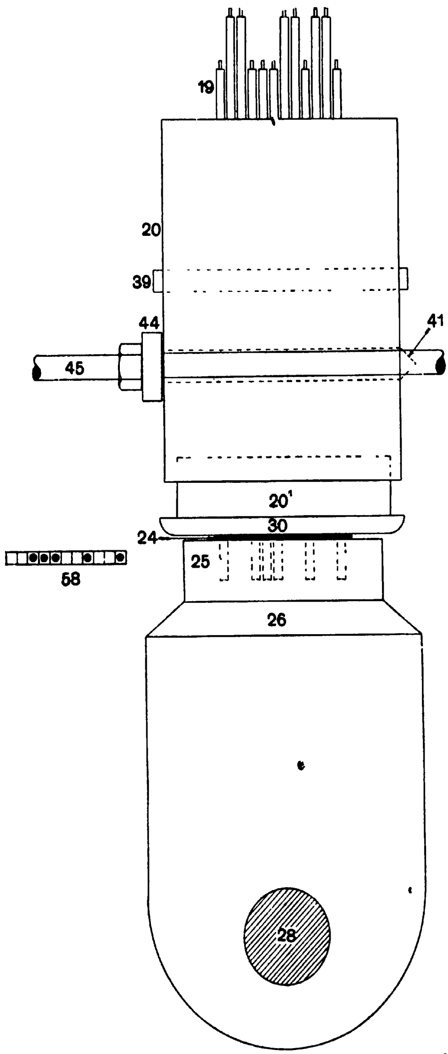


FIG. 315.

The single line 58 of 12 marked and unmarked squares on the left of Fig. 315 indicate the positions of the 12 punches in this view; those punches which correspond to the marked squares are shown with their ends through the card 24. In order that the work of punching a complete card may be done with a reasonable consumption of power, it is usual to vary slightly the lengths of the cutting part of the punches; thus, three different lengths of punches may be made, so that the medium-length punches commence to enter the card a little after the longer punches and a little before the shorter punches.

Much enlarged views of the punches, or, rather, the upper part of them, appear in Fig. 316, with the methods of tying the cords 14 to the punches. In one case, the cord is threaded through a hole in the flat part of the punch, and tied in the usual way; in the other

case, the cord is passed downwards through a vertical hole, then through one of the holes at the side, and a big knot tied on the end; when this knot is pulled inside the punch as illustrated, it offers no obstruction to the vertical movement of adjacent punches. The upper part of the drawing of the right-hand punch is a section through the hole.

It now remains to show how the card 24 is removed from the ends of the punches 19 when the blocks 25 and 26 descend to the position indicated in Fig. 312. The parts which perform this function are illustrated in

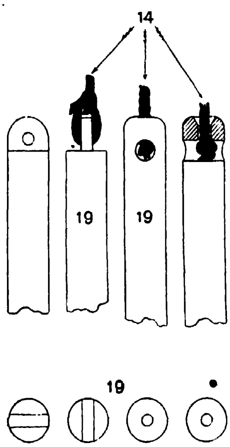


FIG. 316.

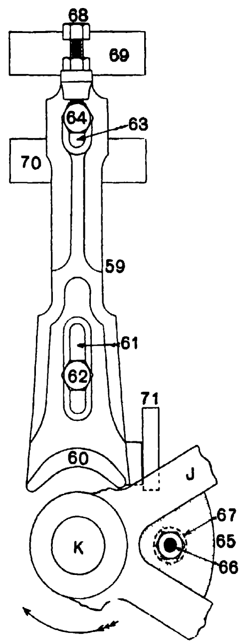


FIG. 317.

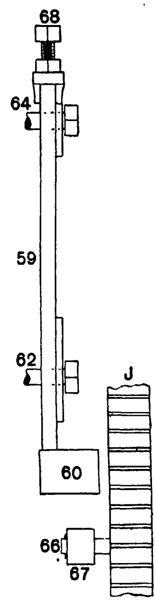


FIG. 318.

Fig. 303, but more particularly in Figs. 317 and 318. On each side of the machine, although not shown in Fig. 306, is a vertical plate 59, to the lower end of which is cast a projecting cam 60. A longitudinal slot 61 is made near the lower end of the plate 59, and through this slot the shaft of a stud 62 passes and is attached to the ends of the bottom block 26, Figs. 307, 308, and 312. A second but shorter slot 63, Figs. 317, 318, and 307, is made near the upper end of the plate 59, through which the shaft of a stud 64 is passed to make a connection with the clearing plate 30, Figs. 308, 310, 311, and 315. The plate 59 is between the frame F and the large wheel J; part only of the latter appears in Figs. 317 and 318.

In the junction between two of the spokes of the large wheel J is a web 65. A hole through this web serves to carry a stud 66, Fig. 318, upon which rotates an anti-friction roller 67.

When the eccentrics 29, Figs. 307 and 308, commence to raise the block 26, and therefore the stud 62, Figs. 317 and 318, the stud simply moves upwards in the slot 61 until the shaft of the stud 62 reaches the top of the slot; the further upward movement of the block 26 results in the vertical plate 59 being raised along with the similar plate at the other side of the machine. And shortly after the vertical plate 59 commences to rise, the lower surface of the upper slot 63 comes into contact with the shaft of the stud 64, and thus the clearing plate 30 is raised, and ultimately the card is punched.

The further rotation of the shaft K causes the lifting cams or eccentrics 29, Fig. 307, to present their thin surfaces to the block 26, and thus the latter is free to descend. The cutting plate 25 and the clearing plate 30 descend simultaneously with the block 26; the clearing plate, however, sticks, so to speak, because of the tightly fitting punches in the holes of the card, but the cutting plate 25 and the block 26 descend to their lowest positions. Meanwhile, the anti-friction bowl 67, Figs. 317 and 318, rotating with the large wheel J in the direction indicated in the former figure, approaches and finally reaches the left-hand side of the projecting cam 60. As the bowl 60 is approaching the vertical position—*i.e.* above the crest of the upper surface of the cam 60—it is gradually forcing down the cam, so that when the latter, and therefore the plate 59 of which it forms a part, has been forced to its lowest position, the lower end of the stud 68 (see top of Fig. 317) has similarly forced the clearing plate 30 off the ends of the punches, and the ends of the clearing plate then rest on the lower plate 70 until the next upward movement of the plate 59. On the opposite side of the machine, Fig. 307, an anti-friction roller 67^1 on the back of the cam L operates in a similar manner on the cam 60 of the vertical plate 59.

The clearing plate 30 is adjusted and timed by means of the above-mentioned stud 68 and its lock-nut. The two plates 69 and 70 are bolted to the main frame of the machine (see Fig. 303), and a vertical spindle, extending from the upper plate 69 to a point below the lower plate 70, serves as a guide for the up-and-down motion of the cutting and clearing plates, while the lug 71, cast on the side of the frame, serves also as a guide for the plate 59.

If we assume as a starting point the rotation of the large wheel J, Fig. 303, when the jacquard griffe is full up and the cylinder S for the pilot cards Q full out, then the following Tables XIV. and XV. will give the approximate rotation in degrees of the marked point in the wheel J

from the highest position of the point, for the time of the chief actions of the machine :

TABLE XIV

JACQUARD MACHINE

Angle of Rotation of Large Wheel J.	Positions of Various Parts.
360° or 0°	Griffe up, cylinder out.
45°	Griffe commencing to descend, and cylinder starts to move in.
120°	Griffe nearly down, and cylinder in.
150°	Griffe full down.
180°	Griffe begins to move up.
210°	Cylinder begins to move out.
260°	Cylinder just about to turn on to the flat side.
270°	Cylinder on the flat side.
310°	Cylinder full out and griffe nearly full up.
310° to 360°	Very slight movement of griffe.

TABLE XV

REPEATING MACHINE

Angle of Rotation of Large Wheel J.	Positions of Various Parts.
360° and 0°	Feed and delivery cylinders 22 and 23 stationary ; sliding knives 41 full in ; punching blocks 25 and 26 commence to rise.
60°	Punching plate and card 24 reach the clearing plate 30.
100°	Punches 19 ready for cutting holes in the card.
150°	Card punched with both plates full up ; both plates commence to descend.
160°	Punching plate 25 moving away from punched card and clearing plate.
175°	Small anti-friction roller 67 commences to act on the cam 60 of the vertical plate 59.
180°	Cam 57 operating on levers and arms to force sliding knives from slots in the punches.
200°	Clearing plate forces punched card off the ends of the punches.
270°	Sliding knives commence to move inwards into the slots.
300°	Sliding knives full in; punching plate and block reach lowest position, and commence to rise again.

It might just be stated that the laced cards which are to receive the impressions or holes identical with those on the pilot chain Q, Fig. 303,

are placed under the lingoe box 13 and on the floor. The end of the chain is then passed behind a roller and led up to the feed cylinder 22, under the punches 19 and clearing plate 30, over the delivery cylinder 23, and finally over rollers to be delivered on to the floor after each card has been cut according to pattern. The discs of card which are punched ultimately leave the cutting plate 25 and drop into the wooden box 71.

Fig. 319 illustrates the delivery and balance-wheel sides of a machine made originally by Messrs. William Ayrton & Co., Manchester. The cards from the delivery cylinder were removed in order that the cylinder might be seen quite clearly; the box for catching the punched-out discs of cardboard which drop through the converging conductor 58, Fig. 321, was also removed from its position, so that the main shaft M and the large plate cams 32 could be exposed to view. In Fig. 320, however, which is exhibited mainly to show the pulley side of the machine and the train of wheels for conveying motion to the two cylinders over which the cards to be repeated are passed, the set of repeated cards is in position, and so is the above-mentioned box. This view also shows the pilot set of cards on the right or feed side of the machine.

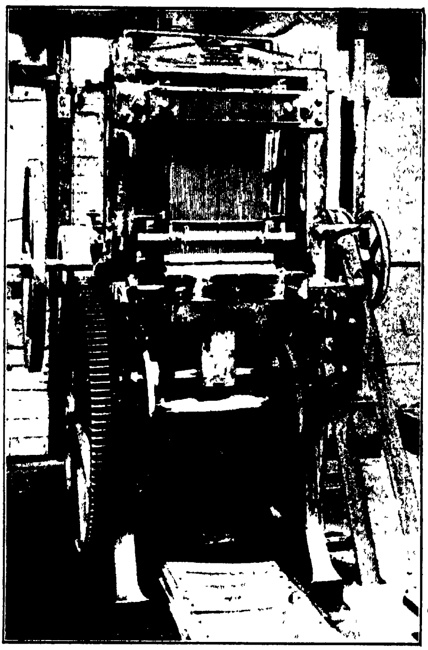


FIG. 319.

One distinctive feature about this machine is that there are no cords required for operating the punches, since the needles of the pilot jacquard control directly the upper part of the punches, or rather the rods which act upon the actual punches. The drive is by means of cones, and in this case an underground shaft supplies the power to the machine, illustrated in Fig. 320, as is clearly shown by the belt. In Fig. 321, which is a line drawing of the delivery side of the machine, the flanged belt pulley A is recessed as indicated to fit the cone B on the driving shaft C. On

the same shaft C, and outside of the belt pulley A, is fixed the hand-wheel D. The cone B is placed in and out of contact with the recessed part of the pulley A by means of a clutch E operated by a hand lever F. The hand lever F is kept in the inoperative position—that shown in Fig. 321—by means of the latch G, so that the latch must be lifted before the handle F can be moved to place the cone B in contact with the inner inclined surface of the driving pulley A.

The pulley shaft C extends to the other side of the machine, where at the extreme end of the shaft is a heavy balance-wheel H, whilst between this balance-wheel and the substantial frame J is a pinion K which drives the large wheel L on the main or cam-shaft M.

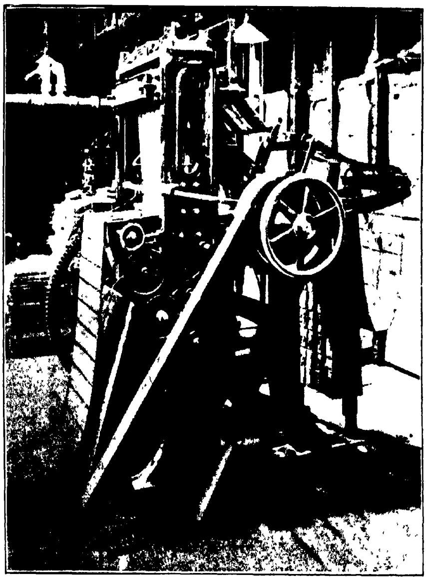


Fig. 320.

Returning to the delivery side in Fig. 321, the two lifting cams 2 are shown in their proper positions on the heavy main or cam-shaft M, with the thin parts of the cams 2 in contact with the anti-friction rollers 3, and hence the latter are in their lowest position. The anti-friction rollers 3 are carried by the shaft 4, and the latter controls the up-and-down movements of the lifting and punching block 5. The cards are "repeated" or punched, one full card at a time, between the lower punching block 5 and the upper plate 6, one card 7 being in position in Fig. 321.

The shaft M is also seen in Fig. 322, which illustrates an end elevation of the balance-wheel end, and the method of feeding the pilot set of cards N. This set of cards, which will have been punched in an ordinary piano machine, laced in one or other of the usual ways, and then wired, is placed in the card cradle O, Fig. 322. The inner ends of the card cradle are secured to two projecting brackets P on the main upright frames J.

One end of the laced set of cards N is led around roller Q, over and under rollers R and S supported by suitable brackets, over the cylinder T, and finally back to the card cradle O, where it is joined to the other end

if necessary to form a closed chain. The card wires U enable the cards to depend to the desired depth; in the case illustrated the wires are attached at intervals of 12 cards, which represent 12-row cards for a 600's jacquard.

The action of the jacquard needles and supplementary parts will be

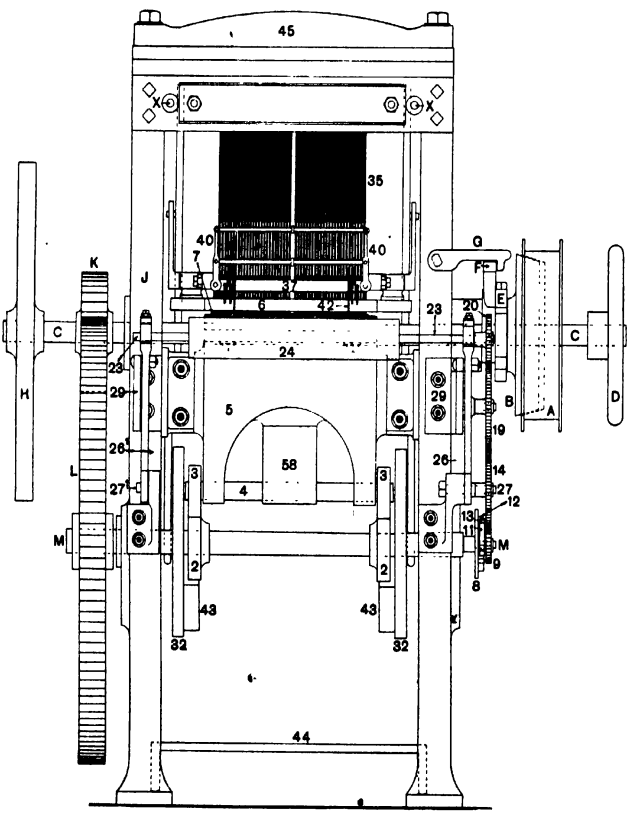


Fig. 321.

described in a sectional view; in the meantime it will be observed from Fig. 322 that there is the usual form of catch V to act on the lantern W of the cylinder T, and so turn the latter one-quarter clockwise as the slide rods X move out under the influence of the collar Y and other mechanism which will appear in the sectional views. A second catch Z may be raised in contact with the underside of the lantern W, and held there by means of a spring attached to any convenient part of the cylinder frame, when it

is desired to rotate the pilot cards N and the cylinder T counter-clockwise, as in symmetrical patterns; in such cases the upper catch V is obviously raised clear of the cylinder lantern.

The shaft M, Fig. 321, extends across the machine, and at the end which projects outside the frame on the pulley side is reduced to take

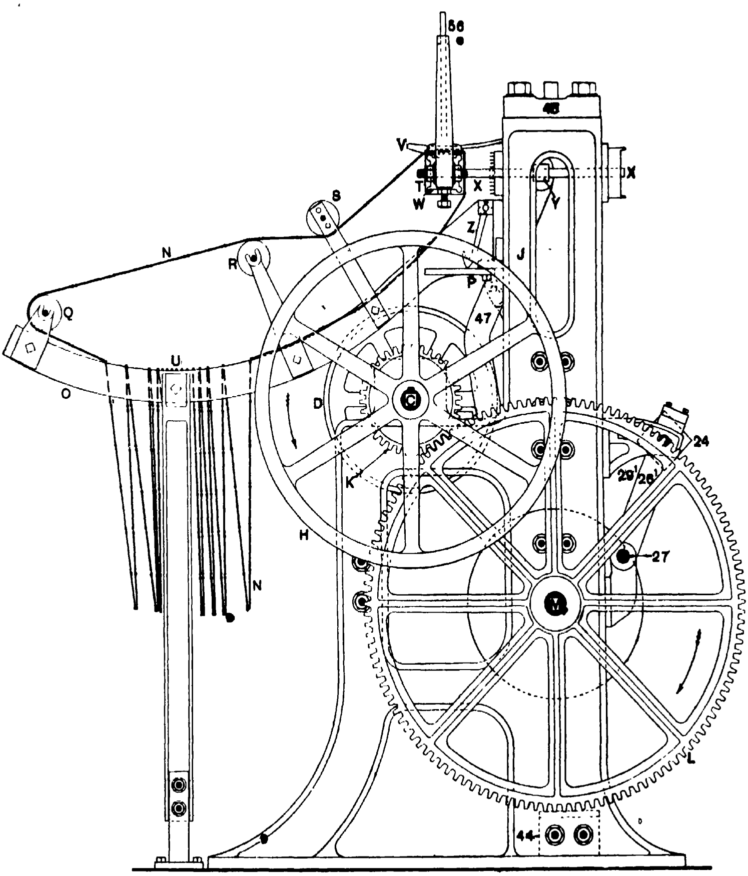


Fig. 322.

the bead and peg disc 8. (See also the elevation of the pulley side in Fig. 323.) The bead and peg disc works in conjunction with the star-wheel 9. As the shaft M rotates, Fig. 323, the bead 10 of the disc 8 runs on one of the curved parts 11 of the star-wheel 9; but when the end of the bead 10 curved part 11, the peg 12 of the disc 8 enters the

slot 13 of the star-wheel 9 and turns the latter one-quarter of a revolution. The star-wheel 9 thus rotates intermittently the two trains of wheels 14, 15, 16, 17, and 18, and 14, 19, and 20. The bead and peg disc rotates counter-clockwise in Fig. 323, and since there are odd numbers of wheels between it and the two wheels 18 and 20—*i.e.* 5 wheels in the first train and 3 wheels in the second train—the wheels 18 and 20 will also rotate counter-clockwise. Wheel 18 is on the shaft 21 of the feed cylinder 22, while wheel 20 is on the shaft 23 of the delivery cylinder 24.

The two trains of wheels for driving the feed and delivery cylinders counter-clockwise, when viewed from the pulley side in Fig. 323, are supported by arms 25 and 26, both fulcrumed in the stud 27, which carries the wheel 14 common to both trains of wheels. Suitable brackets from the arms 25 and 26 form supports for the wheels; some of these are shown distinctly in Fig. 321, and so is the companion arm 26^1 on stud 27^1 supporting the other end of the shaft 23 of the delivery cylinder. The slot 28 in bracket 25, Fig. 323, provides means for altering the position of the shaft 21 of the feed cylinder 22, while the slots in the two brackets 29 provide similar means for the adjustment of the shaft 23 of cylinder 24. An adjustable bracket, with the two holes in different planes for the shafts of the feed cylinder 22, supports the latter at the balance-wheel side of the machine, while a somewhat similar provision is made for the shaft immediately behind wheel 18, Fig. 323. Since no compound-wheels appear in the trains of wheels to the cylinders 22 and 24, and since wheels 9, 18, and 20 contain each 40 teeth, it follows that, each time the star-wheel 9 is moved by the peg 12 of the disc 8, each of the above-mentioned three wheels will be moved 10 teeth, or one-quarter of a revolution.

The cards 30, Fig. 323, which are being punched, move in the direction of the arrow, and are guided by roller 31 to the feed cylinder 22 as demonstrated in Figs. 324 and 326, which, with Figs. 325 and 327, illustrate sectional views of some of the chief parts of the machine.

In Fig. 324 the lifting cam 2 on the main shaft M is in its lowest position, and so is the anti-friction bowl 3 and the lifting-block 5. The large plate cam 32 (see Fig. 321 for the position of this and its companion disc) is described later, or at least the opposite side of the disc to that shown in Figs. 324 and 326. In Fig. 326 the cam 2 and the connecting parts are in their highest positions. Both blocks 5 and 6 are raised at the same time to the position indicated in Fig. 326.

All the needles 33, Fig. 324, are full out (one short row only is shown), and they would still remain in their present positions if a full row of holes —say 12, as indicated above the cylinder T at 34—came opposite them with the next inward movement of the cylinder. Consequently all the rods 35, which are the equivalent of hooks in the ordinary jacquard

machines, would remain as illustrated. And if the block 5 were to rise, all the punches 36 in the upper block 37 would be raised; and since their upper parts are cup-shaped as illustrated on a very large scale in Fig. 327, the rods 35 would be raised, and their upper ends would be arrested by

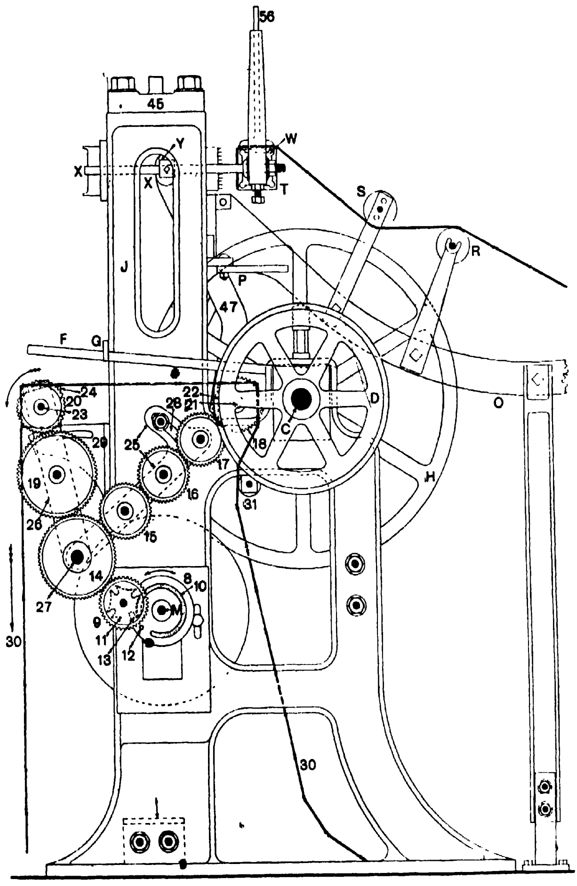


FIG. 323.

the stationary griffe or brander 38, Fig. 324, before the lifting block 5 reached its highest position; hence, the cutting surfaces at the lower end of the punches 36 would pass through the card which at the moment happened to be between the plates 5 and 6.

If, on the other hand, a card with holes and blanks on the same line as

at 39, Fig. 326, should be presented to the needles 33 as depicted in that figure, those needles opposite the places corresponding to the blank squares in 39 would be pressed back as indicated, and, when the block 5 lifted the punches 36 and the rods 35, those rods which had been pressed back by

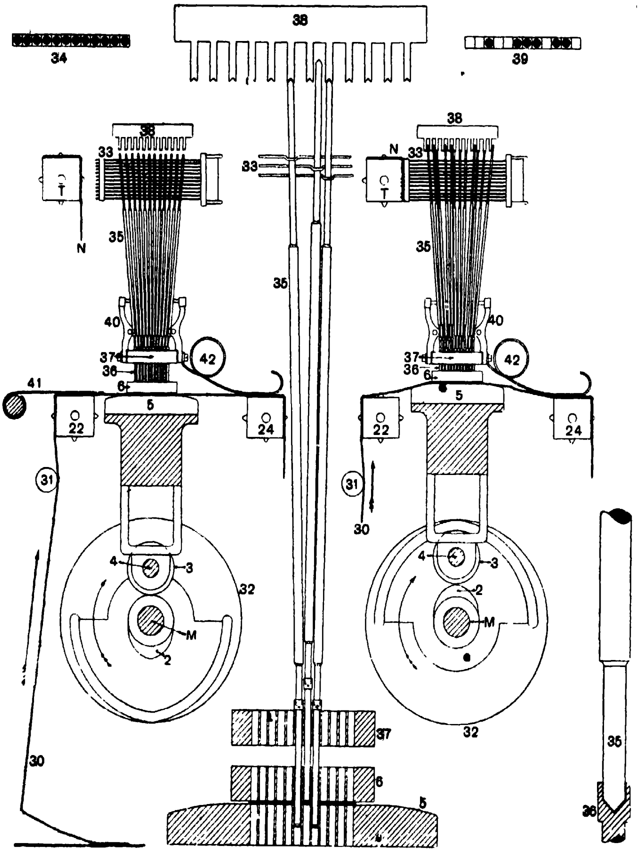


FIG. 324. FIG. 325. FIG. 326. FIG. 327.

the needles would enter the gaps between the depending arms of the stationary griffe 38, while the remainder would come in contact with the Λ-shaped ends as explained, and thus the line on the card between the plates 5 and 6 would correspond to the line 39.

An enlarged view of three needles, three rods, and three punches appears in Fig. 325. The two outside rods are in contact with the depending arms of the griffe, and their punches are through the card, whereas the middle

rod is free—having been pressed back—and its upper end is in one of the gaps of the griffe, because its punch has simply raised it, as demonstrated, due to the blank or uncut part of the card between the plates 5 and 6. All the punches are guided in a true vertical movement by the holes in the upper fixed block 37; the middle block 6 rises with the lower one.

The rods 35 are contained in a skeleton frame 40 composed of suitably shaped vertical bars and round horizontal rods, while springs 41 and 42, the former a straight one for the feed cylinder 22 and the latter coiled for the delivery cylinder 24, serve to keep the cards in their proper positions. The bead 43, Fig. 321, on the disc 32 would force the bowls 3, and therefore the block 5, downwards if the latter showed any tendency to stick.

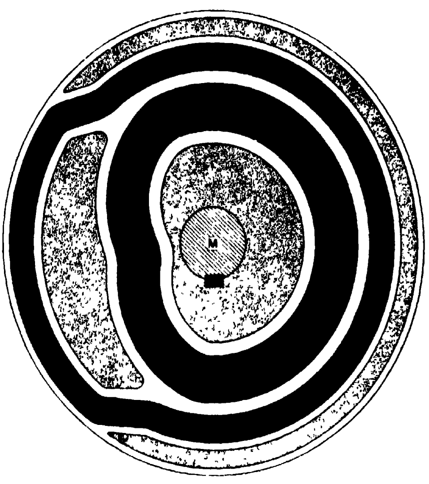


FIG. 328.

The reverse side of plate cam 32, as compared with Figs. 324 and 326, is exhibited in Fig. 328. The outer and narrower box cam is not now used, but the function of the inner and broader box cam (both are in solid black) is demonstrated in Figs. 329 and 330. Both views are partly diagrammatic, and yet the parts are very similar to the actual parts in the machine; and both views are of the inside of the frame in the lower parts. The broad rail which bridges the gap between the two upright frames J is shown at 44; the heavy upper cross rail 45 is fixed to the same uprights as shown. The inner and broader cam only in Fig. 328 is reproduced in solid black in Figs. 329 and 330, and 180 degrees separate the two positions.

An anti-friction roller 46 rotates freely in the box cam of disc 32, and thus imparts a to-and-fro movement to the lever 47, fulcrumed at 48. The upper part of the lever is bent, as shown, and at the extreme upper end carries a pin or stud 49 which enters a vertical slot in the bush Y of the slide rod X for the cylinder T. As the shaft M rotates from the position indicated by the parts in Fig. 329 to that shown in Fig. 330, the lower arm of lever 47 is moved to the left and the upper arm to the right, and hence the cylinder T and the card are brought into contact with the needles

projecting through the needle-board 50. Conversely, during the following half-revolution of shaft M and disc 32 the cylinder is moved outwards to the position shown in Fig. 329.

As the cylinder T and card are approaching the needle-board, and the punching or lifting block 5 is moving upwards to punch the card between the blocks 5 and 6, it is desirable and essential that the card should occupy its exact position with regard to the blocks 5 and 6. A pin 51 is situated in the slot of the longer arm of the bell-crank lever 52, while the shorter arm of the lever controls a part 53 with a vertical pin 54. This pin 54 enters the peg-holes of the card 55 during the above movement, so that the card is held securely in position during the operation, as exemplified in Fig. 330.

The catch Z, Fig. 330, is shown in position for reversing the direction of the cards, and the usual spring hammer 56, with the spiral spring around its upper shank, is clearly seen. A 600's or 12-row cylinder is in position in Fig. 330, but a 400's or 8-row cylinder T is shown in Fig. 329. An 8-row card 55 is also in the cutting position. When it is necessary to repeat an 8-row set of cards, the two upper long rows and the two lower long rows of needles are covered with the angular plates 57, Fig. 329. It is also necessary to introduce similarly sized cylinders instead of the 12-row ones illustrated at 22 and 24 in Figs. 323, 324, and 326, and to make adjustments on the arms 25, 26, and 29 in the former figure. Six 12-row cards bridge the gap between the cylinders 22 and 24 in the above illustrations, but eight 400's or 8-row cards are required.

The feed side and driving end of the jacquard card repeating machine, made by Messrs. James M'Murdo, Miles Platting, Manchester, are illustrated in Fig. 331. This machine, as well as those which have already been illustrated and described, is for repeating ordinary pitch jacquard cards. An illustration of the delivery side and the opposite end to the driving of a very similar machine, made by the same machine-maker, appears in Fig. 332. It will be noticed that the upper parts of the two machines are almost identical, but the lower part of the framework of the machine shown in Fig. 332 is of a heavier build than the corresponding part of the frame in Fig. 331.

As in the other machines, that illustrated in Fig. 331 is adapted for cutting 8-row and 12-row cards of the usual 400's and 600's types. On the other hand, the machine illustrated in Fig. 332 is of more modern type, having just been introduced by Messrs. James M'Murdo, and has been designed for the repeating of cards of a much finer pitch. Otherwise, the illustrations are typical of the two ends, feed and delivery sides of the ordinary pitch repeater made by the above firm.

The difference between the actual cutting parts and the adjacent

mechanism will be understood by reference to Figs. 333 and 336, which illustrate details of the punch, and complete views of punches, hooks and connections, and locking knives. Fig. 333 shows the fixed and moving blocks A and B, the fixed knife C, the moving, sliding, or locking knife

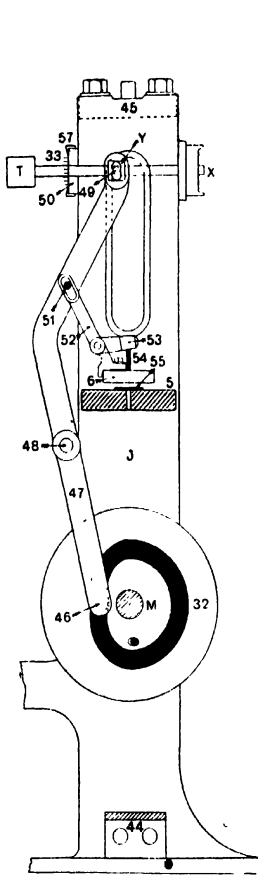


FIG. 329.

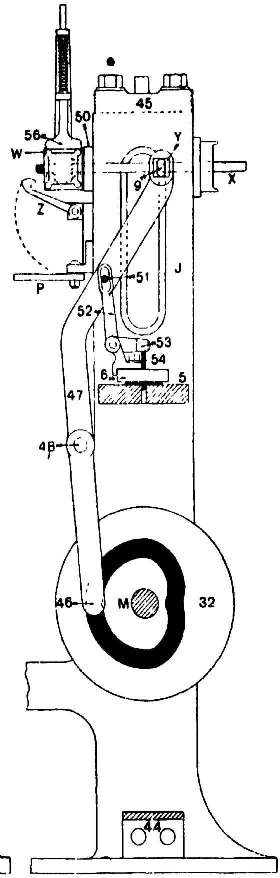


FIG. 330.

D, with the bell-crank lever E which operates the knife D. The bell-crank lever E is fulcrumed at F. The short arm of the lever E is raised by the cam G, which rotates with the main shaft H. As the latter rotates in the direction indicated by the arrow, the short arm of lever E will rise, and the long arm will move to the right and withdraw the locking knife D.

In the present view, the locking knife D is full in, and in the position essential when the actual operation of punching a card is taking place.

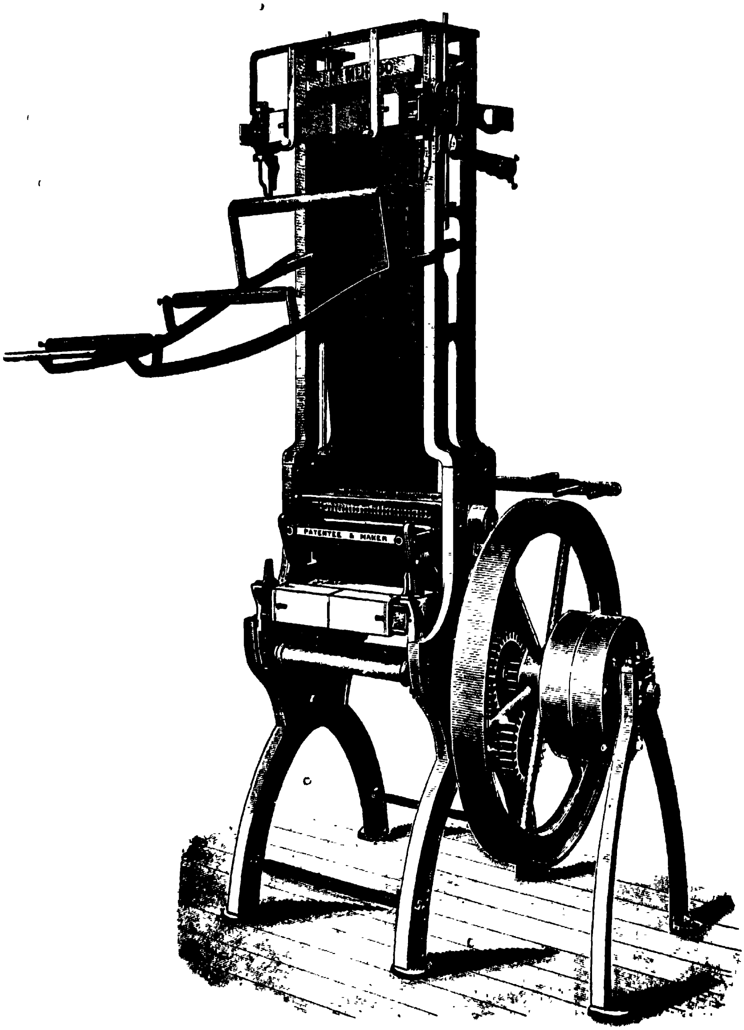


Fig. 331.

The view in Fig. 333 shows that there are twelve punches J, and therefore the illustration shows one short row of the ordinary card repeater for 600's cards; it can, of course, be made suitable for punching 500's and

400's cards, and for any other with fewer punches than 600's, provided the length of the card is the same as those for the ordinary 600's cards.

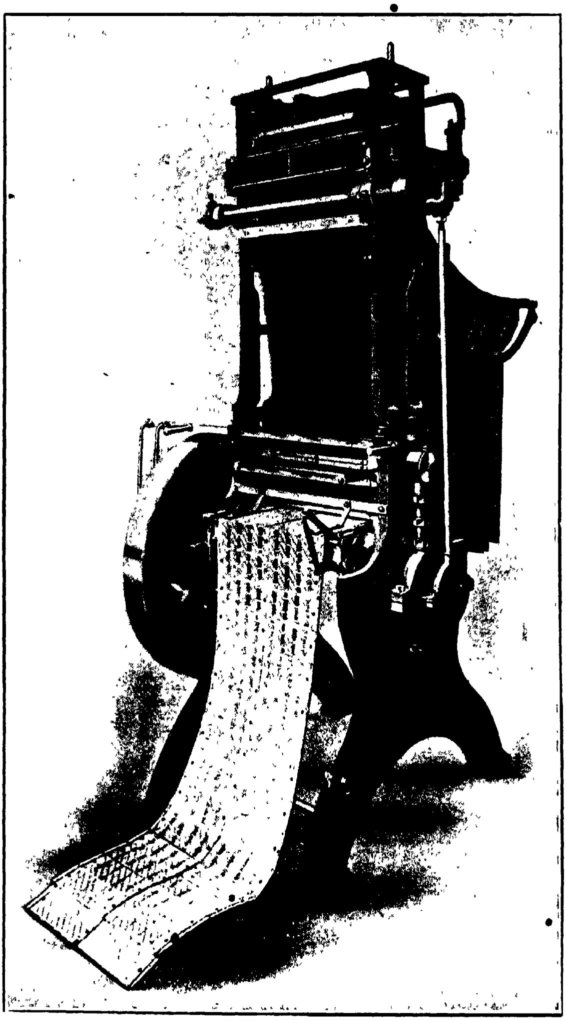


Fig. 332.

The five punches J in Fig. 334 are also representative of the punches for the ordinary pitch repeater, but they are drawn to a larger scale than the parts in Fig. 333; they are drawn one-tenth the actual size, and so

is the single punch J^1 in Fig. 334. All the connections for this punch are also shown up to the knife, but the punch itself has been drawn 90° round, instead of in its actual position, in order that the shape might be more clearly shown. It will be seen that the punch J^1, Fig. 335, is much smaller than, although exactly the same length and shape as, the punches J, Fig. 334, also marked 1, 2, 3, and 4 on the right. The punch J^1 and the attached parts in Fig. 334 are for the medium pitch repeater.

The difference between the two pitches is perhaps better illustrated in the two parts of cards at the bottom of Fig. 336. Both cards are the same in width, so that 16 holes in the medium pitch card occupy the same width as 12 holes in the ordinary pitch card, and the same proportions obtain in the length. In the 600's ordinary pitch card, $16\frac{1}{4}$ in. $\times$ $3\frac{1}{2}$ in., there are

$$\left.\begin{array}{l} 26 \text{ rows} \times 12 \text{ holes} = 312 \\ 25 \quad ,, \quad \times 12 \quad ,, \quad = 300 \end{array}\right\} = 612 \text{ holes};$$

while in the above-mentioned medium pitch card, termed a 1350's, $19\frac{1}{8}$ in. $\times$ $3\frac{1}{2}$ in., there are

$$\left.\begin{array}{lrlr} 1 \text{ part row} & \times 12 & \text{holes} & = 12 \\ 41 \text{ rows} & \times 16 & ,, & = 656 \\ 2 \text{ part rows} & \times 12 & ,, & = 24 \\ 42 \text{ rows} & \times 16 & ,, & = 672 \\ 1 \text{ part row} & \times 12 & ,, & = 12 \end{array}\right\} = 1376 \text{ holes.}$$

And since the same kind of cardboard can be used in both machines, it follows that with any constant sett or porter about half the weight of cards will be used for the medium pitch repeater and jacquards as compared with the weight used for the ordinary machines.

A sectional view of the punching plates and blocks is introduced in Fig. 337. This view shows provision only for 8 punches J of the ordinary pitch—a sufficiently large number for descriptive purposes. It will be understood, however, that in this repeater there are 12 punches in each short row, as indicated in Fig. 333 and by the upper card in Fig. 336; in the medium pitch repeater there are obviously 16 punches per short row, and of the size indicated by that marked J^1, Fig. 335. The punches in Fig. 337 are drawn one-fifth the full size, and are therefore twice the dimensions of the hooks J, Fig. 333.

Before describing the manipulation of the punches, it might be advisable to consider the full complement of parts up to the jacquard machine which carries the pilot set of cards to be duplicated. In principle, as already stated, the medium pitch punch J^1 is the same as those of the ordinary pitch; indeed, it differs from them only in the diameter of the steel. Hence, any description having reference to the ordinary pitch punches is applicable to the medium pitch punches.

The jacquard machine, the position of which will be indicated later, contains 12 ordinary lifting knives, one of which is shown at K in con-

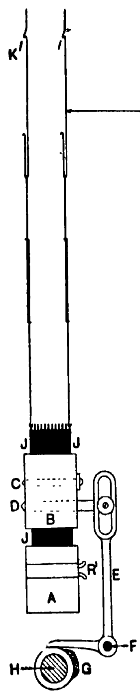


FIG. 333.

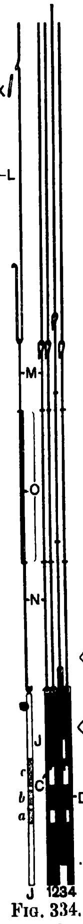


FIG. 334.

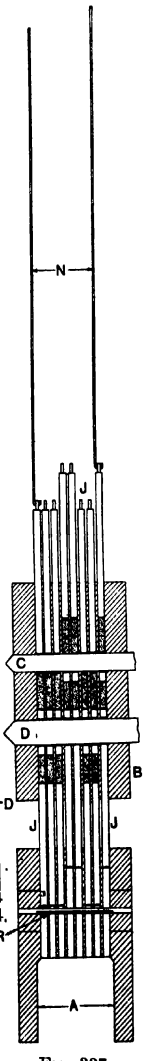


FIG. 337.

FIG. 335.

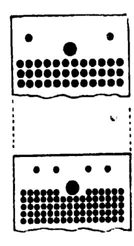


FIG. 336.

nection with the first punch of the 5 in Fig. 334. The upper part of the hook or upright L for the ordinary pitch machine differs slightly from the medium pitch upright L, Fig. 333. Narrow knives K are used for the

ordinary pitch jacquard, but deep knives are used for the medium pitch machine.

To the bottom bent part of the hook L is attached a wire M, as indicated in Fig. 334; the bent lower end of the wire M is provided with a hole through which the lower wire N passes, and the latter in turn has a similar bend at the top through which the wire M passes.

Encircling the upper part of wire N, and extending the distance marked O, is a fine-wire spiral spring. The hooked end of the wire N is finally attached to the punch J, and this completes the equipment. The normal position of the hook L is off the knife K, and not on, as is usual with ordinary jacquards.

Each punch has three sections cut away to form recesses, as shown in Fig. 334, on the punches J—also marked 1, 2, 3, and 4—and the corresponding parts *a*, *b*, and *c* are shown stippled on the adjoining punch J, which is set 90° further round than the four punches. The cut-away portions are also shown clearly in Fig. 335. The two lower recesses in Fig. 334 are ¾ in. deep, while the upper section is 1½ in. deep, all cut half-way through the diameter of the punches.

Along the full 52-row width of the machine these punches are arranged in pairs, the cut-out recesses of each facing each other as clearly indicated. When the jacquard griffe is down, and the selection of needles is taking place, all the punches are in their lowest positions, as shown in Fig. 333. Holes on the pilot cards have no effect on the needles nor on their corresponding hooks L; hence the hooks and all attached parts will remain in their lowest positions, and as indicated by punches 1, 2, and 4, Fig. 334. On the other hand, a blank at any point on the pilot card would act on the corresponding needle, and the latter would push its hook over the knife K, in which case all attached parts would be lifted, and the punch would take up the position shown by punch 3.

It has already been stated that there are two knives in the punching block—a fixed one C and a locking one D. The ends of the 26 fixed knives C—each knife controls two punches—are shown in the elevation of the feed side in Fig. 338; the ends of the locking knives D are not shown, but they are immediately behind the plate D^1, and the latter is attached as exemplified to the upper arms of the bell-crank levers E.

When the selection of needles is taking place—*i.e.* when the jacquard cylinder P and the pilot card are in close contact with the needle board Q (see Fig. 339)—the levers E and the locking knives D will be full out, as indicated by the positions marked E^1 and D^1, Fig. 339, so that all selected punches are free to rise. Those hooks L which have been pushed by their needles over the knives K will be lifted, and the corresponding punches raised to the height represented by punch 3, Fig. 334. This action will

place the recess a of punch 3 to the same level as recess b of the unaffected punches 1, 2, and 4; the long recess c enables this to be done in spite of the position occupied by the fixed knife C, which serves to keep all recesses

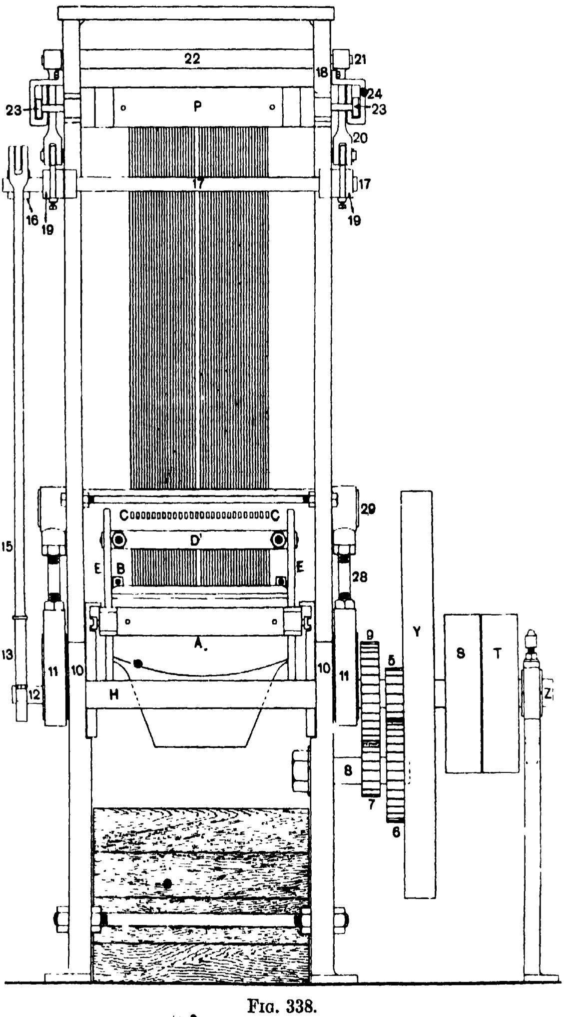


FIG. 338.

a, b, and c clear for the knives to enter and leave. It will thus be seen that when the jacquard griffe carries up the knives, and the cylinder P is moved by the swan-neck (not shown) to the outer position as shown in Fig. 340,

the recesses *a* of all lifted punches J and the recesses *b* of all unaffected punches J will be in the same horizontal plane, and ready to receive the 26 locking knives D as the latter are moved forward under the influence of the parts illustrated in Fig. 333. When these movements have been effected, the parts will be placed as are illustrated in the sectional view in Fig. 337, and the card R to be punched will be in position over the holes in the bottom punch block A.

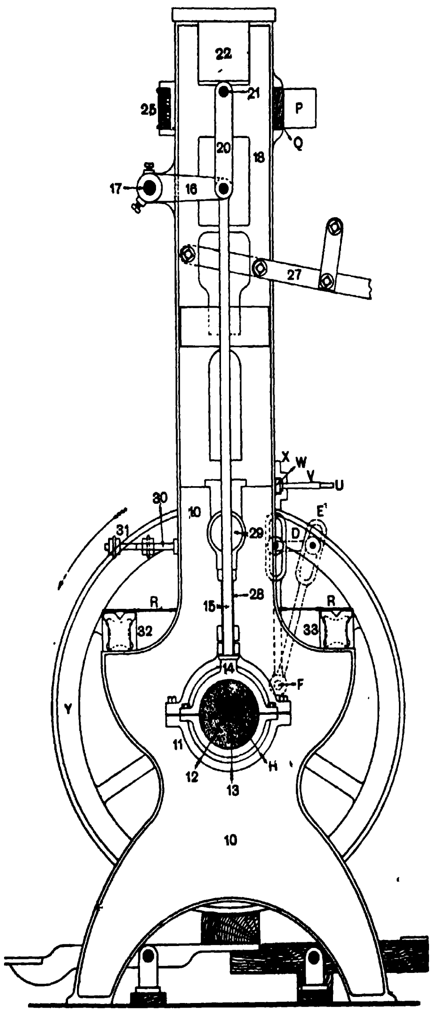


FIG. 339.

All the punches J are thus clear of the card—an essential condition when the latter is being drawn forward under the punches—but it will be observed that punches 4, 5, and 8, Fig. 337, are pretty high up in the upper block B, whereas punches 1, 2, 3, 6, and 7 are just sufficiently raised to allow freedom of movement as the cards are entered between the blocks at R^1, Fig. 333, and when they are being withdrawn after the punching operation is completed.

The machine is usually placed in and out of action by means of fast and loose pulleys S and T, and a belt guided by the belt fork U, Figs. 339 and 340, and operated by the handle V on the bar W, which can be slid in the brackets X.

The pulleys S and T, and the balance-wheel Y, Fig. 338, are on the

shaft Z, and so is the driving pinion 5 of 30 teeth. The pinion drives the wheel 6 of 60 teeth compounded with pinion 7 of 30 teeth on stud 8, and pinion 7 drives wheel 9 of 60 teeth on the main shaft H. This shaft, as shown in Fig. 338, extends through the machine, and near each end and immediately outside of the substantial frame 10 is placed an eccentric and strap 11, Fig. 339. Finally, the end of the shaft H is turned down to the diameter at 12, as shown in Fig. 338, and a smaller eccentric 13 secured to it.

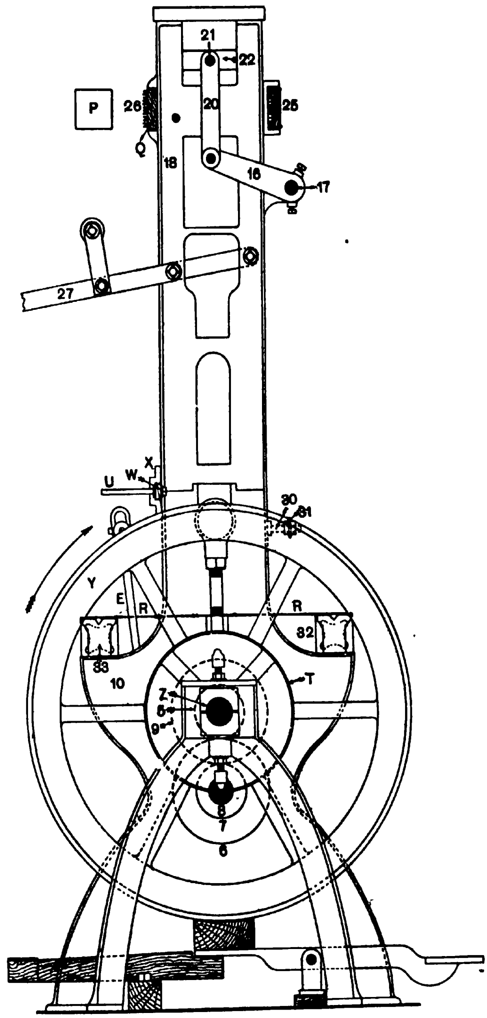


Fig. 340.

The strap 14 of the small eccentric 13 is connected with the rod 15, and the latter in turn to the lever 16 fulcrumed on shaft 17, which extends to the other side of the jacquard 18. Near the outside frames of the jacquard, and fixed on the shaft 17, are two other levers 19, the ends of which are connected to links 20, and these links to studs 21 on the ends of the lifting griffe 22. The slide rods or bars 23, Fig. 338, support the pivots of the pilot cylinder P, and the rods 23 slide in the brackets 24 under the usual influence of the griffe 22 and a swan-neck. These parts are not shown in the end elevations in Figs. 339 and 340, since these parts are subsidiary in this case to the punching and selecting mechanism; and in Fig. 340 the cards R

are shown full for clearness, although they are obviously inside the frame 10.

The customary spring-box 25 is provided, and the needles 26, Fig. 340, are acted upon in the usual way by cards which pass over the cylinder P from the card cradle 27; part only of the latter is shown in the line drawings, but two types of cradles are shown quite distinctly in Figs. 331 and 332. The two eccentrics are also prominent in the latter figure.

The straps of the large eccentrics 11, Figs. 338 and 339, are connected by the rods 28 to studs 29 projecting from the sides of the upper block B, Figs. 338 and 339. Hence, as the eccentrics 11 rotate with the main shaft H, the rod 28, studs 29, and block B will rise and fall alternately for each revolution.

Two positions of the lever E are shown in Fig. 339; the oblique position marked E^1 represents the full-out position when all the locking knives D

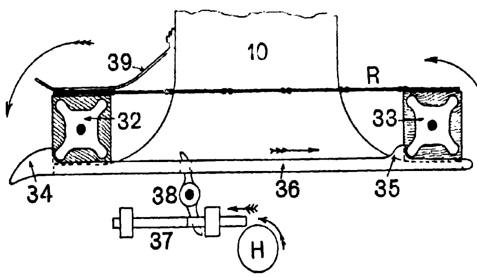


FIG. 341.

are clear of the punches J. The vertical position of the lever E represents the full-in position of the locking knives J. It has already been stated that the locking knives are pulled out positively by the action of the cam G, Fig. 333, on the short arm of lever E. This results in the compression of a spiral spring (not shown) on the rod 30, Fig. 339, and situated between the collar 31 and the block B. The energy thus stored in the spring enables the latter to draw in the locking knives D when the action of cam G, Fig. 333, is removed. At this time the griffe 22 will be up, and all parts ready for the block B descending to perform the cutting of the holes. As the block B descends, the fine spiral spring at O, Fig. 334, is compressed a little, and continues to be so until the block B reaches the lowest position, and the otherwise unaffected punches J have passed through the card R.

When the punches J have been withdrawn from the punched card, the latter is carried from between the cutting blocks, and another blank card of the chain placed in position by the partial rotation of the cylinders 32 and 33, Fig. 341. These cylinders are moved by means of the two

catches 34 and 35 on rod 36. The latter is moved positively by means of a cam on the shaft H which pushes the short rod 37 to the left, and the latter moves the lower arm of lever 38 in the same direction, so that the upper arm of the latter pushes the rod 36 to the right, and thus turns the two cylinders one-quarter round and in the direction indicated by the arrows. The rod 36 and other parts are returned to their present positions by means of a spiral spring.

The spring 39, attached to the frame 10, and a similar spring on the other side, serve to position the cards on the cylinders 32 and 33.

There are other repeaters on the market for the duplication of the ordinary and medium British pitch types of cards, but those illustrated and described probably represent the best known kinds. Whenever a certain pitch jacquard machine becomes permanently established in an industry, a corresponding repeater is almost sure to follow in due course, because of the saving which is effected by such machines.

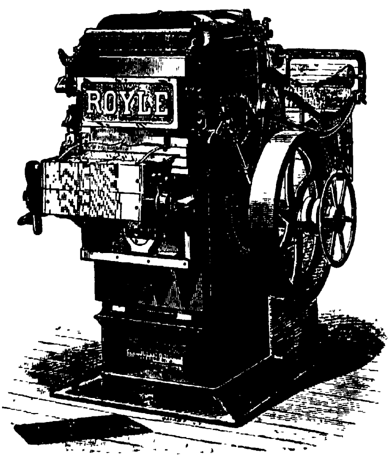


FIG. 342.

Some duplicating or repeating machines are most suitable for repeating single cards of particular picks of simple weaves, or of all the picks in succession. Thus, in connection with the weaving of figured fabrics which require cross borders, there are usually large quantities of cards, cut for some simple weave, required to be used between each pair of cloths. In such cases, and also in the case of preparing stock cards of a similar nature, these machines are very useful. They are not intended or adapted to cut cards which have been previously laced.

The cards cut from such a machine can then be stored on suitable pegs so that one or more can be taken and used when desired for any particular purpose.

These particular kinds of repeating machines may also be used for the duplication of full sets of cards which have not been laced, but which have just come from a piano-card cutting machine, say from any of those illustrated in Chapter IV.

The American repeating machines appear very compact, as evidenced

by Figs. 342 and 343; these illustrate respectively a French index repeater and a fine-scale repeater. It is impossible at present to show any of the actual cutting mechanism or the parts which operate it, but it might be stated that all parts, such as cords, chains, and springs, have been replaced by shafts, levers, gears, and similar appliances, so that the various movements may not, when set, be subject to variations which invariably accompany the use of the former group. Finally, the jacquard card cylinder is made of brass, and hence it is not affected by atmospheric changes.

It will be seen that in both the machines illustrated in Figs. 342 and 343 cards of the usual kind are used and laced, but it should be noted that the so-called fine-scale repeater is really what we have called a medium-scale machine (see Fig. 332), as the actual pitch is identical with the McMurdo medium pitch repeater illustrated there.

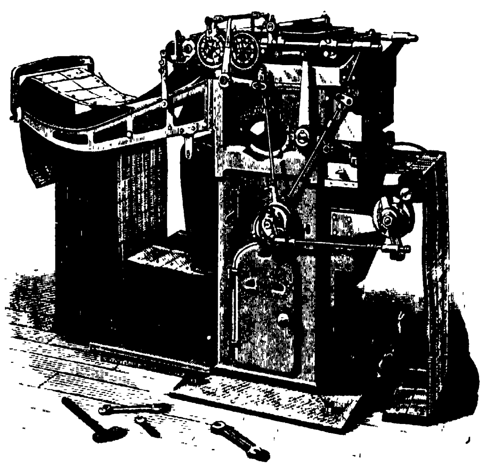


FIG. 343.

The lacing for the cards may be accomplished on any suitable type of lacing or stitching machine.

We have already mentioned the fact that some repeating machines are constructed specially to duplicate unlaced cards which have been damaged while in use, as well as for punching stocks of cards of the same simple weave throughout. Thus, in the manufacture of linen, cotton, and union damask tablecloths and serviettes or napkins, and, in general, in the weaving of all kinds of figured textures other than piece-goods—*e.g.* cloths, covers, and the like—it is almost invariably necessary or desirable to introduce a number of cards, punched for simple weave throughout, for the purpose of weaving the length required for the plain part of the cross borders as well as for that part which is to be utilised for hemming the ends of the cloths.

Such cards are seldom cut from the actual figured design; in the first case, the actual number required is not always known when the design is being painted, and even if it were, it is not essential to have the correspond-

ing weft lines painted or the weave inserted. A much simpler plan is to have all such cards made independently of the design. They may be made on any of the repeating machines already illustrated; but they are often made individually by a pair of machines such as those illustrated in the foreground in Fig. 344, and when punched, it is a good plan to hang each set on a pin, as indicated in the upper part of the figure, so that one or more of each kind can be taken off quickly, either for replacing a similar broken one, or for forming the required number to add to those representing the actual figured portion of the design when the latter set is ready for lacing.

The view in Fig. 344 illustrates part of a card-cutting, repeating, and lacing room. The two machines involved are often termed respectively a "repeating machine" and a "railway press." The so-called repeating machine—which is, however, actually a punch selecting machine—is shown on the right, while the railway press, or actual punching machine, is shown on the left. There is another railway press in the background. It will be noticed that the arms of the large hand-wheel in the far machine are clearly seen, whereas those belonging to the hand-wheel of the nearer machine are invisible; the pulley, shaft, and wheel were running when the photograph was taken, and this accounts for the obliteration of the arms in the illustration. We shall have occasion to refer to this figure again when the line drawings of the two machines appear.

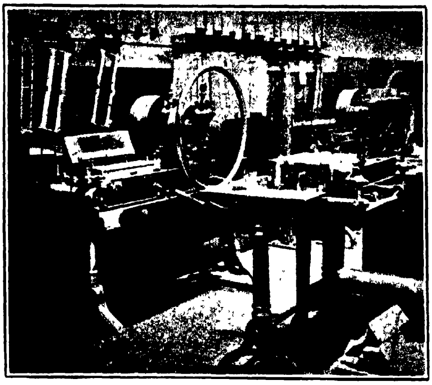


FIG. 344.

The first machine of the pair used for duplicating cards in the case of damages, or for a very slow method of repeating a set of cards, is illustrated in Fig. 345. We use the term "very slow" in reference only to the duplication of one set; if several sets of the same design were wanted, the machine would then be much more valuable, as will be explained later. As a matter of fact, the illustration Fig. 345 shows that the machine is arranged for the latter function, because there is a set of cards A on the cylinder B of the machine, and the cylinder is in the same plane as the needles. In this case it is seen that the machine is operated by means of a treadle C. After each downward movement of the treadle, the latter is returned

to its present position by the weight D. But since at its best such a machine, when working in conjunction with the "railway press," is but a poor substitute for the modern card repeater, we shall describe the two companion machines for the purposes already mentioned in connection with Fig. 344. We shall, however, letter the illustration in Fig. 345 in keeping with the line drawings of the same machine as at present adapted for the duplication of single cards.

An elevation of the same end of the machine as that shown in Fig. 345

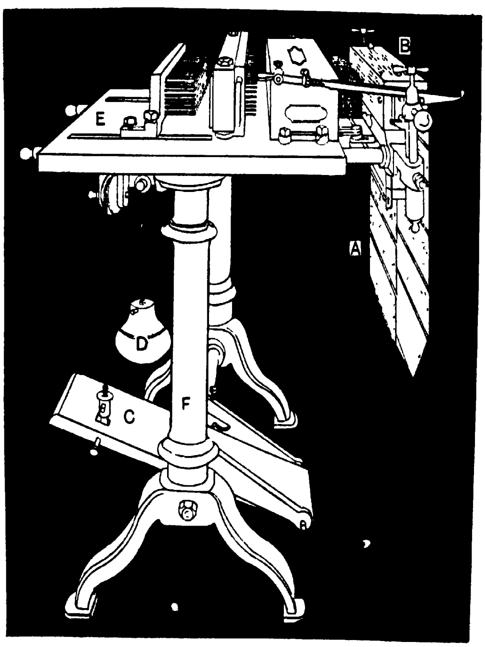


FIG. 345.

is reproduced in Fig. 346, but in this case the card cylinder B is shown in a much higher plane with respect to the other parts of the machine, and the cylinder B is without pegs—they are not required with this arrangement. A very similar disposition of the various parts is exemplified in Fig. 347, which represents a different type of machine made by another firm of machine makers, but adapted for the same kind of work; in this case, a treadle C is used, but it is returned by means of springs D, and the treadle and springs are connected by metal stirrups and flat leather bands which are supported by rollers, as shown.

The table E of the machine, Fig. 346, is firmly mounted on the end

frames F, and the table in turn supports all the parts which are essential for the selection of the proper punches. There are two sets of needles G and H, and one set of punches J, each set numbering 600. The needles G and H are much smaller than the punches J; the latter must, obviously, be the same size as those of the ordinary pitch piano

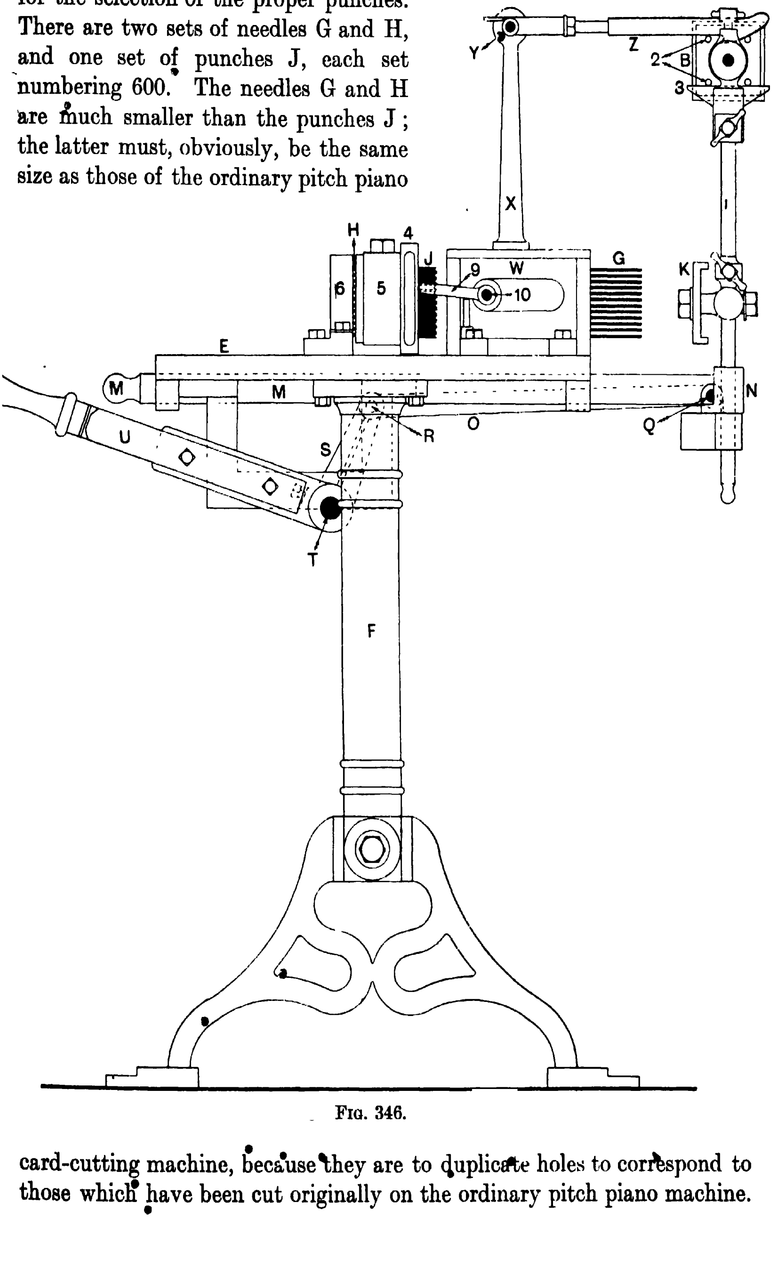


FIG. 346.

card-cutting machine, because they are to duplicate holes to correspond to those which have been cut originally on the ordinary pitch piano machine.

The parts are in their normal position in Fig. 346, and also in Fig. 348, which is a plan view of the table and its furnishings. The card to be duplicated, whether as a single card or as one of a set hanging over the cylinder B as illustrated in Fig. 347, is guided on to a pair of pegs on the card plate K, seen best in Fig. 346. This card plate K is secured to the two rods L which support the cylinder B, while the ends of the slide rods M, which are connected by the bar N, as shown in Fig. 348, encircle the upright rods L, as shown. A rod O, Figs. 346 and 348, is attached to the bar N by means of a pin Q, while the other and forked end of the rod O is similarly attached by the pin R to the lever S fulcrumed on the shaft T, Fig. 346. Finally, a lever U, with handle V, is secured to the shaft T.

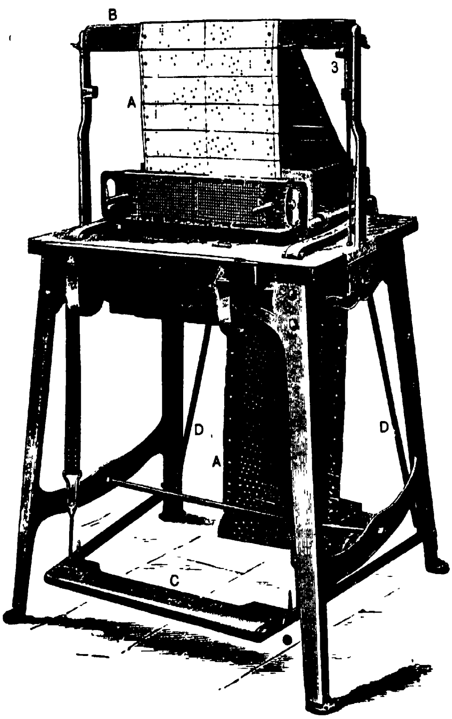


Fig. 347.

The needles G are those which are acted upon directly by the pilot card—*i.e.* the card which serves as the selecting medium for the duplication. These needles G are housed in the case W, and a pedestal X, secured to the upper surface of case W, supports an arm Y, upon which the turning catch Z is loosely fulcrumed. The length of the catch Z can be varied slightly, so that its hooked end will operate satisfactorily on the pegs 2 of the cylinder B when the cards are arranged somewhat as demonstrated in Fig. 347. The pegs 2, when in their normal position, rest upon the head of the spring hammer 3, as indicated both in Figs. 346 and 347.

The punches J, or rather those which are not held for the time being by the punch-carrying block 4 when the latter has been removed from the machine—that is, from the position it occupies in the figure—are located in the stationary punch block 5; while the needles

H, with their carrier 6, are clear of the block 5, as will be indicated shortly.

The method of operating the repeater or punch-selecting machine is as follows: Suppose that the card shown in the upper part of Fig. 349, and numbered 567, to represent the corresponding pick of the design, had to be duplicated because of some damaged part. The two arrows 7 and 8 indicate the directions for reading the holes and blanks with respect to

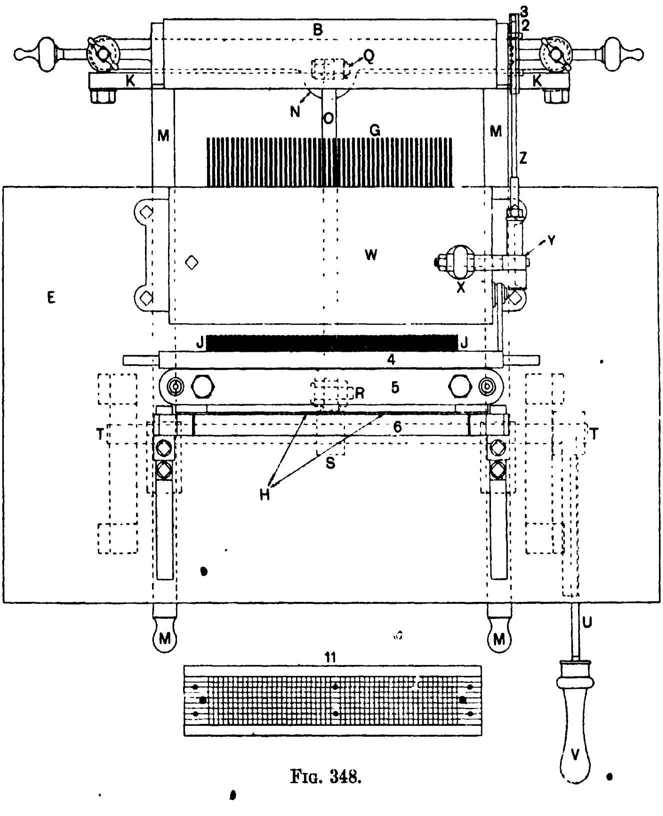


FIG. 348.

the needles 1 to 600 of the machine. The 26-row is on the left and the 25-row on the right when viewed as in Fig. 349. The punches for the peg and lace holes are not required in the case W, because these punches are always in position in the punch-carrying block 4, alongside the ordinary punches J.

The card, say, No. 567, as illustrated in Fig. 349, is placed on the pegs and against the face of the plate K, Fig. 346, so that its 12 long rows of

holes and blanks will face the corresponding 12 long rows of the selecting needles G. The handle V is then pressed down, an action which causes the lever S to move slightly counter-clockwise, and hence pulls the rod O, bar N, plate K, cylinder B, and all adjoining parts to the left, Fig. 346, until the plate K, or rather the card 567, Fig. 349, is in close proximity to the face of the case W.

Since the plate N, Fig. 346, is attached to the lever S, and since a further rod is attached to the short needle carrier 6, it follows that both move simultaneously and in the same direction, but the short needles H, in their carrier 6, are clear of the box 5 before the card on the plate K operates on the selecting needles G.

As soon as the card on plate K reaches the points of the selecting needles G, the blanks will force the corresponding needles against the same number of punches J, and will ultimately force these punches J into the box 5. Those selecting needles G which were opposite holes in the card would pass through these holes and through the corresponding holes in the plate K.

When the moving parts 6, N, etc., Fig. 346, have reached their full outward position to the left, the punches J and the needles G and H will have assumed the positions indicated in the plan view, Fig. 349. In this view all the selecting needles corresponding to the blanks in the top long row of card No. 567 are shown to have pushed their corresponding punches J into the box 5, whereas the remaining punches J, corresponding to the holes in the top row of the card, remain undisturbed, because their needles G have not been acted upon.

It will thus be seen that all those punches J which have not been pushed back, remain in the punch-carrying block 4, and when the needles G and H have been removed to the right, Fig. 346, until the needles G are clear of the punches J, and before the needles H have reached the remainder of the punches J in the box 5, the parts are in suitable positions for the removal of the punch-carrying block 4, with its complement of punches corresponding to the holes in the card No. 567, Fig. 349.

The small arm 9, fulcrumed at 10, Fig. 346, on a stud projecting from the side of the case W, holds the punch-carrying block 4 erect, but can be withdrawn so that the punch-carrying block 4 may be lifted out in order to be transferred to the next machine, the railway press, where the actual punching of the new card takes place. Only one row of needles G and punches J—the top one—has been introduced in Fig. 349, since more would simply have resulted in the illustration being made less effective. The foregoing description has reference to the duplication of 600's or 12-row jacquard cards. Provision must be made to duplicate 8-row and 10-row cards if necessary, and this provision takes the form of plates

drilled for the corresponding 8-row and 10-row machines. Thus the diagrammatic view 11 at the bottom of Fig. 348 illustrates a plate equal in size to a 600's or 12-row card, but 10 long rows only are shown; the places on the plate corresponding to the 1st and 12th rows of a 600's card are solid metal, and hence only 10 rows of selecting needles G, Fig. 346, would be in work, and the two outside long rows of needles would be

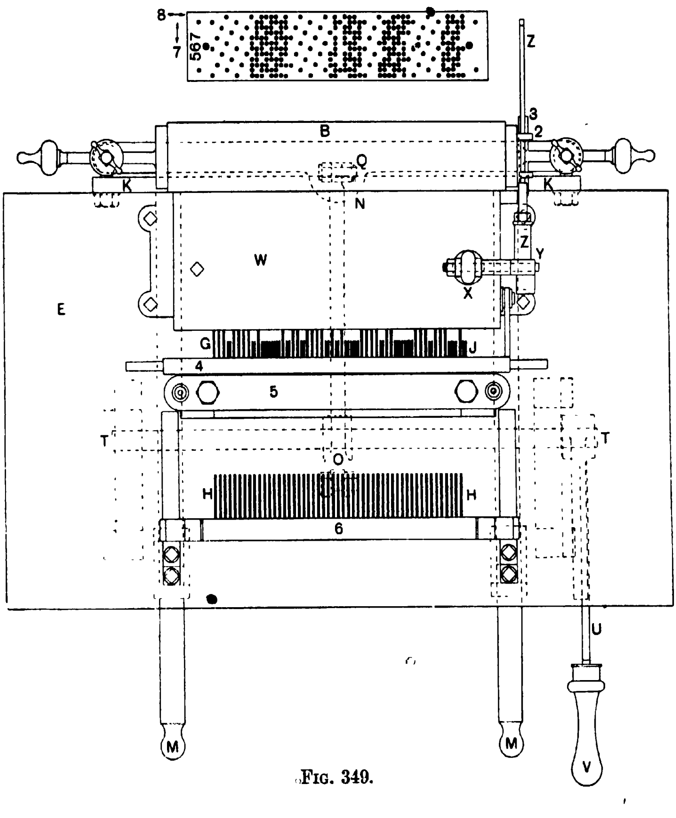


FIG. 349.

pushed to the left and their corresponding punches J pushed into the box 5 at each stroke of the plate. For 8-row or 400's cards the plate would have holes only in the eight middle rows, and it need hardly be said that the plate is placed in front of the plate K, Fig. 346, so that the rows of blanks would cover the holes in the corresponding rows in plate K.

The companion machine to that illustrated in Figs. 345 to 349, and the one which actually performs the punching of the cards, may be hand-driven or power-driven. One type of hand-driven machines is illustrated

in Fig. 350, the drum or roller A being operated by means of the projecting handles on the hand-wheel C. The punch-carrying plate 4 is shown on the top of the framework, and this plate has to be pushed under the roller A, the point where the card is cut. The small discs of cardboard, punched from the card, drop into the box near the floor.

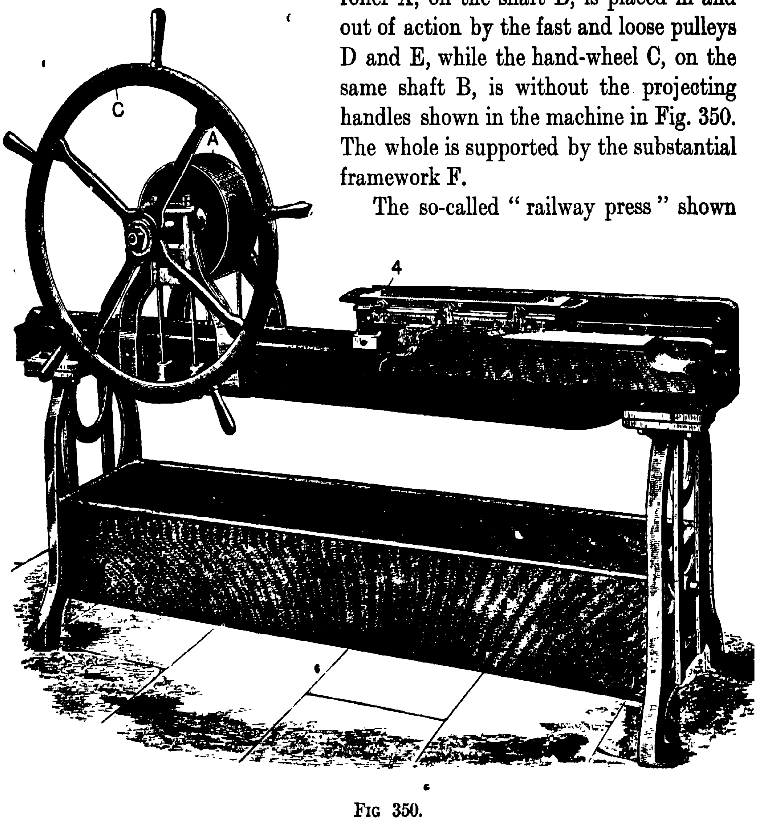


FIG 350.

A power-driven machine is illustrated in Fig. 351, in which case the roller A, on the shaft B, is placed in and out of action by the fast and loose pulleys D and E, while the hand-wheel C, on the same shaft B, is without the projecting handles shown in the machine in Fig. 350. The whole is supported by the substantial framework F.

The so-called "railway press" shown in Fig. 351 is of the same type as those shown near the wall in Fig. 344. It will be observed that in these two machines in Fig. 344, one pulley only is used, the main shaft being kept running while the engine or main shaft is in motion; in this respect the machines differ from that illustrated in Fig. 351.

Figs. 352 to 356 are line drawings of the machine exhibited in Fig. 351. Fig. 352 is a front elevation, Fig. 353 is an end elevation of the feed

side, Fig. 354 is a plan, while Figs. 355 and 356 are enlarged views of the punch-carrying plate 4.

After the selection of punches has been made by the machine illustrated in Figs. 345 to 349, and as already described, the punch-carrying plate 4 is removed from the pins or pegs, Figs. 346, 348, and 349, and the plate with its complement of punches taken to the railway press illustrated in Fig. 350, or to the one shown in Figs. 351 to 356. The plate 4 is placed in the position indicated in Figs. 355 and 356.

We shall assume at present that the blank card which has to be punched is under the punch-carrying plate 4 and between it and a correspondingly drilled plate, near the base of the plate-carrier G; the method of placing the card in this position will be described after the actual operation of punching has been explained.

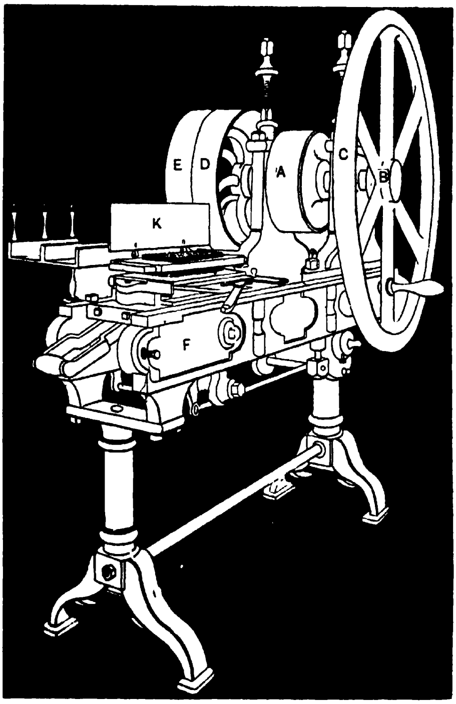


FIG. 351.

The plate-carriage G is, naturally, in its position on the rails H, Fig. 354, although shown detached in Figs. 355 and 356. In Fig. 354 only a small portion of the plate-carrier G is shown, but its handle J indicates its relation to the whole carriage shown in Figs. 355 and 356.

The two rails H, Fig. 354, extend, as shown, to the far end of the machine, and it is necessary, when the card is in position under the plate 4 and its punches, to cover the latter with the leather shield K, Fig. 353 (shown also clearly in Fig. 351). Then the plate-carrier G, with its charge, is pushed under the rotating roller A, with the leather shield K in direct contact with the roller. This results in the punches being forced downwards, and their ends pushed through the card and into the correspondingly drilled plate in the base of the carriage G. The full cutting of the card is thus

accomplished, but it is necessary to withdraw the plate-carriage G in order that the punched card may be removed, and another blank card placed in

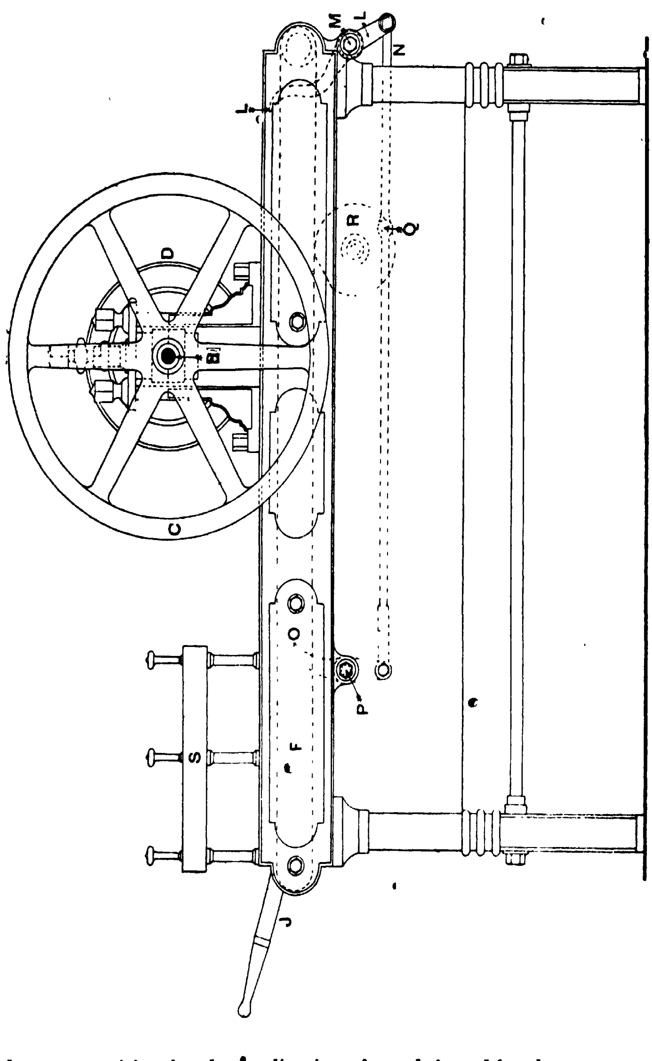


Fig. 352.

the same position for the duplication of another card by the same punches, or by another arrangement of punches selected by a different card in the machine illustrated in Figs. 345 to 349.

Near the right-hand side of the machine is a lever L, Fig. 352, fulcrumed

at M. The upper and longer arm of the lever L is free, whereas the lower and shorter arm of the same lever is attached to the end of the rod N. The rod N extends to a point near the front of the machine, where it is attached to the lower arm of lever O, fulcrumed at P. A pin Q, projecting from the rod N, is in contact with the flat-sided, nearly circular part R; it has a flat part at one point of its periphery, and this disc R is in touch with the rails H.

When the plate-carrier G is on the left, the circular part of the disc R is supporting the rail H; but when the carrier G has passed beyond the roller A, Fig. 352 (that is, when the card has been punched), the end of the carrier G comes in contact with the end of the upper arm of lever L. The end of the lever L is forced to the right, and this causes the lower and shorter arm to move to the left, and hence the pin Q, through the movement of the rod N, rotates slightly the almost perfect disc R and until the flat part is horizontal.

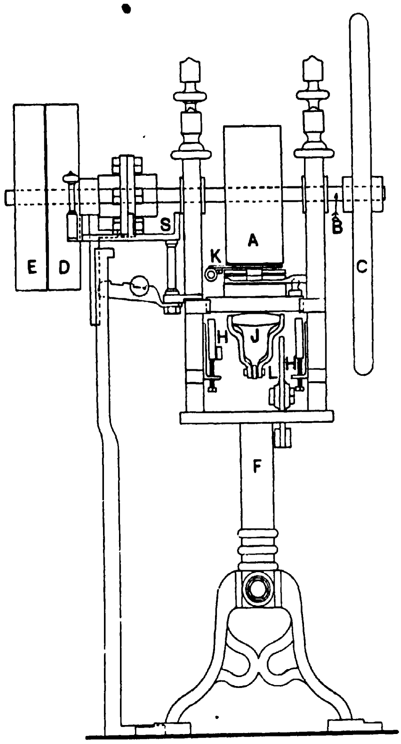


FIG. 353.

The operation of placing the flat part of the disc R horizontal allows the rails H to descend slightly, and this enables the operative to withdraw the plate-carriage G freely and without the leather shield K coming into contact with the rotating roller A. When the carriage G is nearing the left-hand side, the opposite end of the carriage comes in contact with the free end of the lever O, and hence the lower end of this lever causes the rod N to move to the right and to place the disc R in the position shown in Fig. 352 ready for the next forward movement of the plate-carriage G.

As the punched cards are removed from the carriage they are placed in the receptacle S; one compartment may be utilised for the punched cards, as stated, and the other compartment for a stock of blank cards.

It is obvious that the punched card must be removed from the plate-carriage G before another blank card can be introduced; the card is removed in the following manner: The handle J, Figs. 355 and 356, is pressed downwards to lift the plate 4 until the ends of the punches are withdrawn from the lower plate and clear of the punched card. Then a catch is moved to release the handle or lever T, and a pin projecting from the upper surface of the lever T, and about midway between its ends, enters a slot in the card-slide U, and so enables the card-slide, with the punched card thereon, to be withdrawn when the handle T is moved slightly counter-clockwise about its fulcrum. The punched card is then removed from the card-slide U, another blank card inserted in its place, and the handle T returned to its present position to carry the newly inserted blank card immediately under the punches in the punch-carrying plate 4.

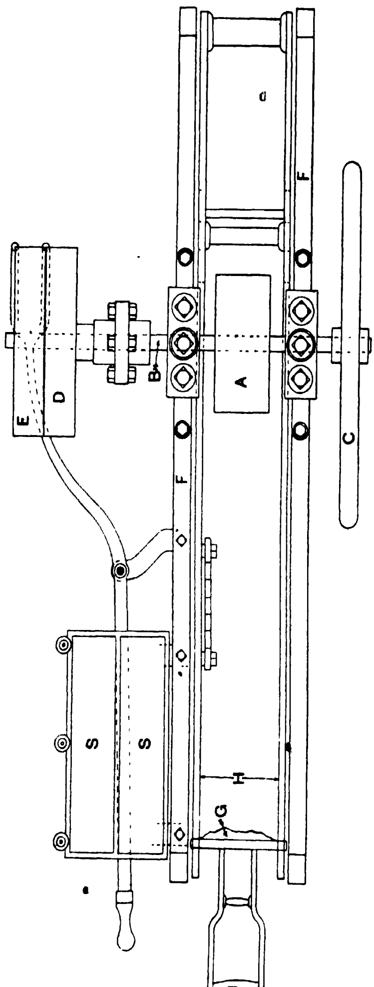


Fig. 354.

It will be understood that 8-row, 10-row, and 12-row jacquard cards will require different kinds of card-slides U. Each card-slide is made so that it will fit the plate-carrier G, and place the card centrally with regard to the peg-holes of the plate.

Two special card-slides are shown distinctly in Fig. 344, hanging against the wall. This illustration also shows clearly the leather shield K which,

as already stated, is turned down to cover the punches in the plate 4 just before the plate-carrier G is pushed under the rotating roller A.

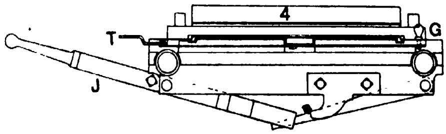


FIG. 355.

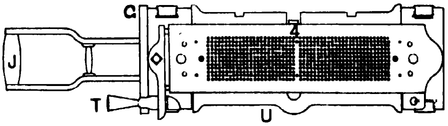


FIG. 356.

This leather shield is open in Fig. 344, and is seen immediately under the above-mentioned two card-slides U ; it is also open in Fig. 351.

CHAPTER XVIII

FINE-PITCH REPEATING MACHINES

THE piano machine used for punching the holes in endless paper cards for the fine-pitch Verdol machine is illustrated and described in Chapter VIII. We propose now to discuss the machine by means of which the pilot set of cards punched on the above piano machine is utilised for duplication purposes in the fine-pitch repeating machine.

A photographical reproduction of a fine-pitch repeater for endless paper cards is illustrated in Fig. 357, this particular view being taken from the back of the machine. This general view of the back, and the side opposite to the drive, illustrates quite well what might be termed the back harness with its heck, lingoes, and other parts, as well as the sliding part of the punch box. It also shows a great part of the arrangement provided for enabling the attendant to mount to the top of the main frame in order to place the pilot cards in position.

The front harness is shown distinctly in Fig. 358, which illustrates the front of the machine, the front of the punch box, card reels or cages, and the driving arrangement. It will be observed that the front harness in this figure, as well as the back harness in Fig. 357, occupies only two-thirds of the full capacity of the machine; this is because, in the particular machine photographed, 880 needles and hooks were in use out of a total of 1320. The width is divided into three sections, as shown by the divisions in the punch box in Fig. 358, each section of which contains 440 needles and hooks.

The above two views will be referred to again later; meanwhile we need only notice that in Fig. 358 there is a long vertical rod between the driving belt and the end of the main frame, and practically parallel to both, which, with other parts, provides means for conveying through the rotary movement of the main shaft and the up-and-down movement of a cam bowl, the usual movements of the lifting griffe of the jacquard at the top of the structure.

The continuation of this lifting rod, or rather the lever to which it is

attached, is shown in the bottom right-hand corner of Fig. 359. The last-mentioned lever is fulcrumed as shown on the heavy horizontal rod or shaft in the front of the jacquard. Two other levers, one at each side of the jacquard, are fulcrumed on the same rod or shaft, and these serve to complete the connection to the two vertical rods which operate the griffe of the jacquard.

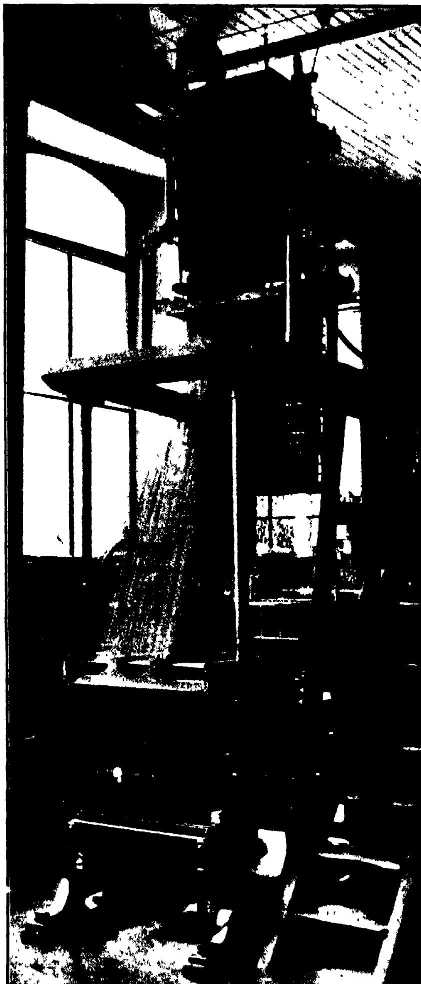


FIG. 357.

As indicated, the illustration in Fig. 359 shows the driving side of the jacquard; the other side, which is slightly different, appears in Fig. 363.

The side shown in Fig. 359 illustrates the mechanism which causes the card cylinder to rotate intermittently, and which keeps it free from vibration after each movement is completed — that is, when the part of the endless paper corresponding to a card has been placed in position under the short vertical selector needles of the Verdol jacquard.

It is not intended to describe the jacquard fully at this stage, but we might mention the fact that the short vertical selector needles are housed in the box in the upper part of the jacquard and immediately above the cylinder. The circular end of the cylinder is clearly seen with the roller of the spring-actuated lever (hammer) in contact to keep the cylinder motionless while the selection is being made. A hole in the paper card below a selector

needle enables the end of the latter to enter, while, on the other hand, a blank keeps the corresponding selector needle in the high position. These selector needles simply place each row of horizontal needles in two distinct horizontal planes, so that some of the latter may be pressed back and others missed in order to place the hooks or uprights of the jacquard in the desired positions. The particular way in which the two sets of cards in Figs. 357 and 358 are actuated will be fully explained later.

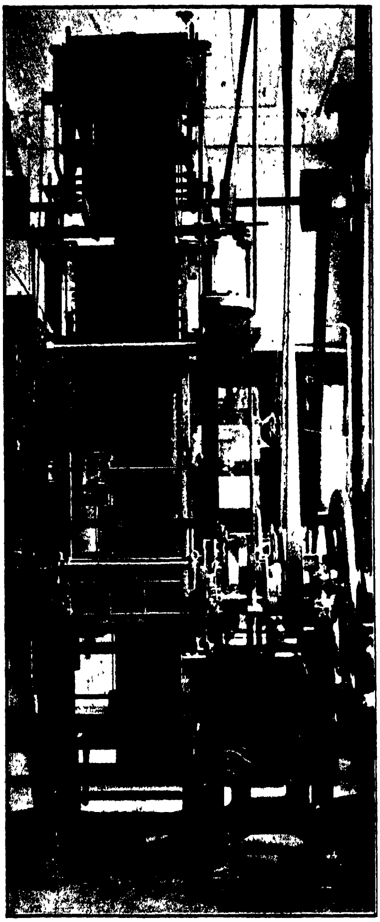


FIG. 358.

It will be understood that the endless paper cards, or rather the wide strip of paper with strengthening strips for the peg-holes, which has been prepared in the fine-pitch card-cutting machines, is passed over the cylinder of the jacquard, while the blank endless strip to be punched or repeated for the same pattern is passed over a corresponding cylinder in the punch box in Fig. 358. On neither cylinder is the paper in position, because it would have covered part of the machine. In Fig. 359, however, the paper strip is shown over one of the guides and between the two bars of the card or paper cradle.

The front of the fine-pitch repeater, corresponding to Fig. 358, is illustrated in the line drawing in Fig. 361, while the method of driving the griffe of the jacquard is shown in Fig. 360. The framework of the machine is in two parts, the high or main frame A, Fig. 361, and the supplementary or low outside frame B; these two parts are kept in their vertical positions by the compound rails C and D. The actual driving parts of the machine

are supported in suitable bearings, and, as shown, between the two frames, while the drive is obtained by a type of friction clutch. On the end of the main shaft E, and outside the supplementary frame B, is the balance

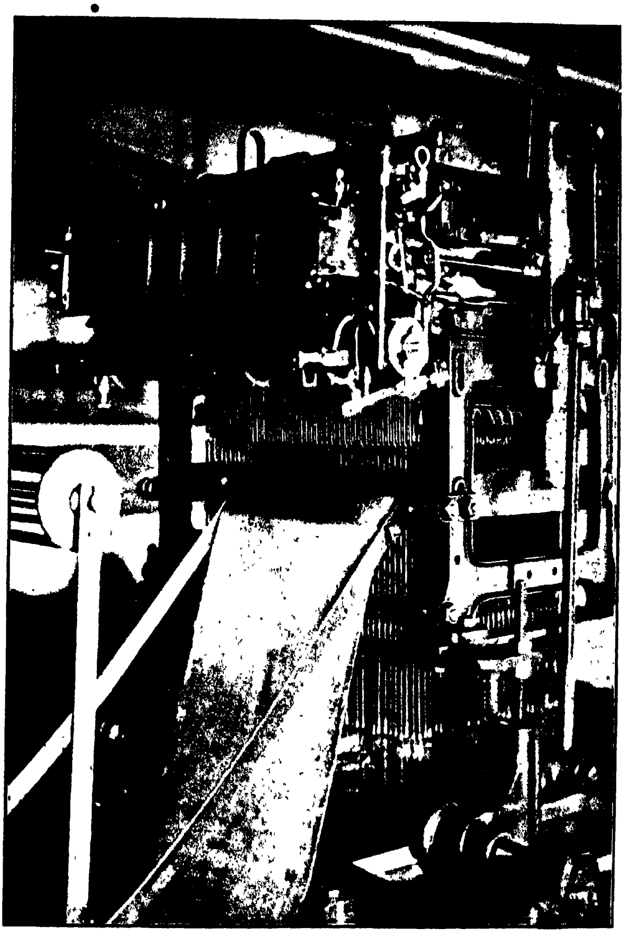


FIG. 359.

and hand-wheel F, while a belt coming from the line-shaft shown in Figs. 357 and 358 communicates the power to the flanged pulley G, Fig. 361. The horizontal arm H, seen best in the end elevation in Fig. 362, and the vertical arm J, Fig. 361, are compounded and fulcrumed at K, and the machine is inoperative when these parts are in the above-mentioned

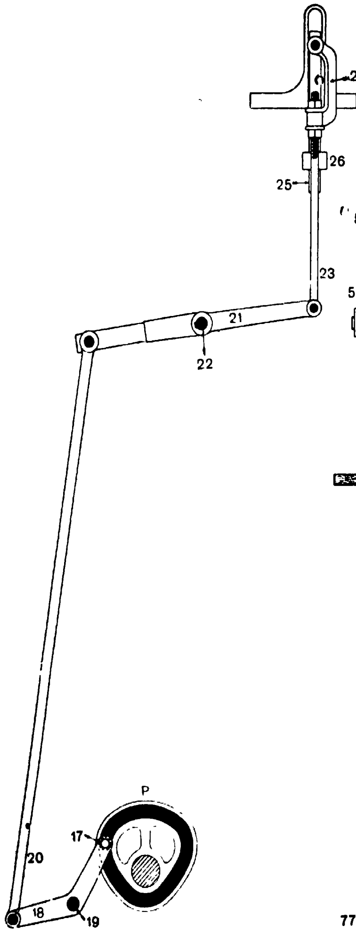


FIG. 360.

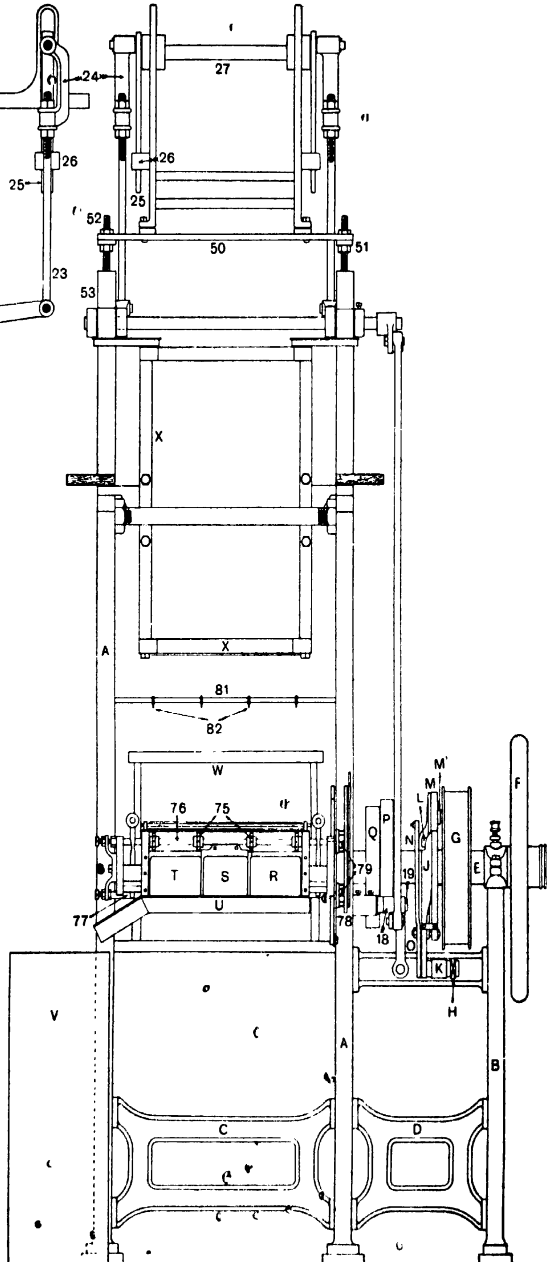
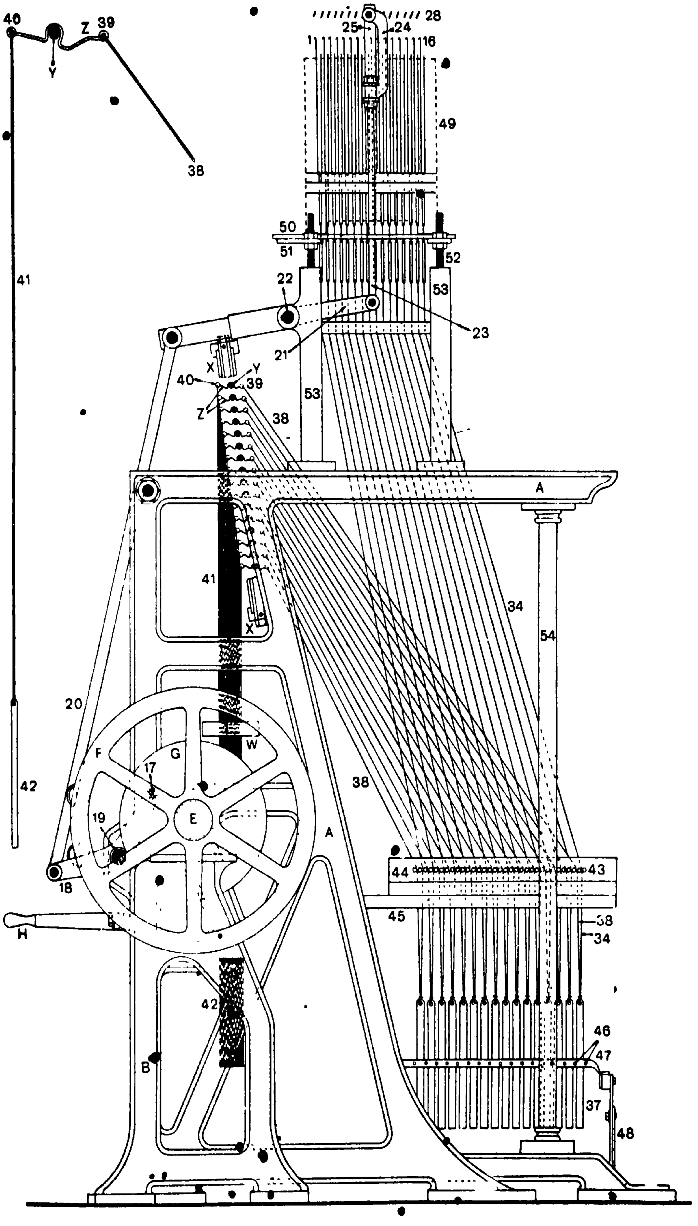


FIG. 361.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F
G
17
38
19
E
A
44
43
18
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38
34
H
42
46
47
B
37
48

FIG. 362.

positions. When, however, the end of the handle H, Fig. 362, is pressed downwards, the upper end of the arm J, Fig. 361, moves slightly towards the operator or reader, and is thus withdrawn from contact with a projecting piece L cast on, or preferably fixed to, the side of the clutch plate M. On the other face of the clutch plate M is a projecting piece M^1 adapted to be withdrawn from, or to enter in, a recess in the inner face of the flanged pulley G. This arrangement enables the upper part of the powerful flat spring N, fixed at O, to slide the clutch plate M on the shaft, and to press the part M^1 sufficiently far into the recess in the inner face of the flanged pulley G to enable the latter to drive the clutch plate M and the shaft E. Conversely, when the handle H is raised to the present position, Fig. 362, the curved part of the upper end of arm J, Fig. 361, is placed in the path of the projecting piece L of the rotating friction plate M, and the piece L is thus caused to slide down the curved part of the arm J and to withdraw the clutch plate M and the part M^1 from contact with the inner face of the driving pulley G. Provision is made to stop the belt from rotating if for any reason such a condition is desired.

On the same shaft E, Fig. 361, are two cams P and Q; the cam P with its connections drives the jacquard at the top of the frame, while the cam Q communicates motion to the sliding part of the punch box. The front part of the punch box is situated immediately behind the three openings R, S, and T, while the gutter U serves to catch and guide the cuttings or small discs punched from the paper strip into the large box V. The front comberboard is shown at W, while the framework X supports all the rods Y, Fig. 362, and the latter serve as fulcra for all the wire levers Z. An enlarged view of one wire Z and its fulcrum rod Y is shown in the detached view on the left of Fig. 362. All these parts shall receive consideration shortly.

In the grooved path of the cam P, Fig. 360, shown 90° farther round, with respect to Fig. 361, is an anti-friction roller 17 running loosely on a stud near the upper end of the bent lever 18 fulcrumed at 19; see also Fig. 362. The long connecting-rod 20 is attached to the outer end of lever 18 and to the long and outer arm of lever 21 fulcrumed on the shaft 22. This is the shaft shown clearly in the foreground in Fig. 359. The shorter and inner arm of lever 21, Figs. 360 and 362, is attached to the vertical rod 23, and the latter is adjustably attached to the lower end of the bent part 24. The upper end of the bent part is attached to a pin projecting from the side of the slide 25, which is guided in its up-and-down movements by the bracket 26, Figs. 360 and 361; see also Fig. 359. It will be understood that the inner part of 21 and parts 23 to 26 inclusive are duplicated at the other side of the jacquard, and that the two sliding bars 25 are attached directly to the griffe frame 27, within which are the sixteen knives 28, Fig. 362.

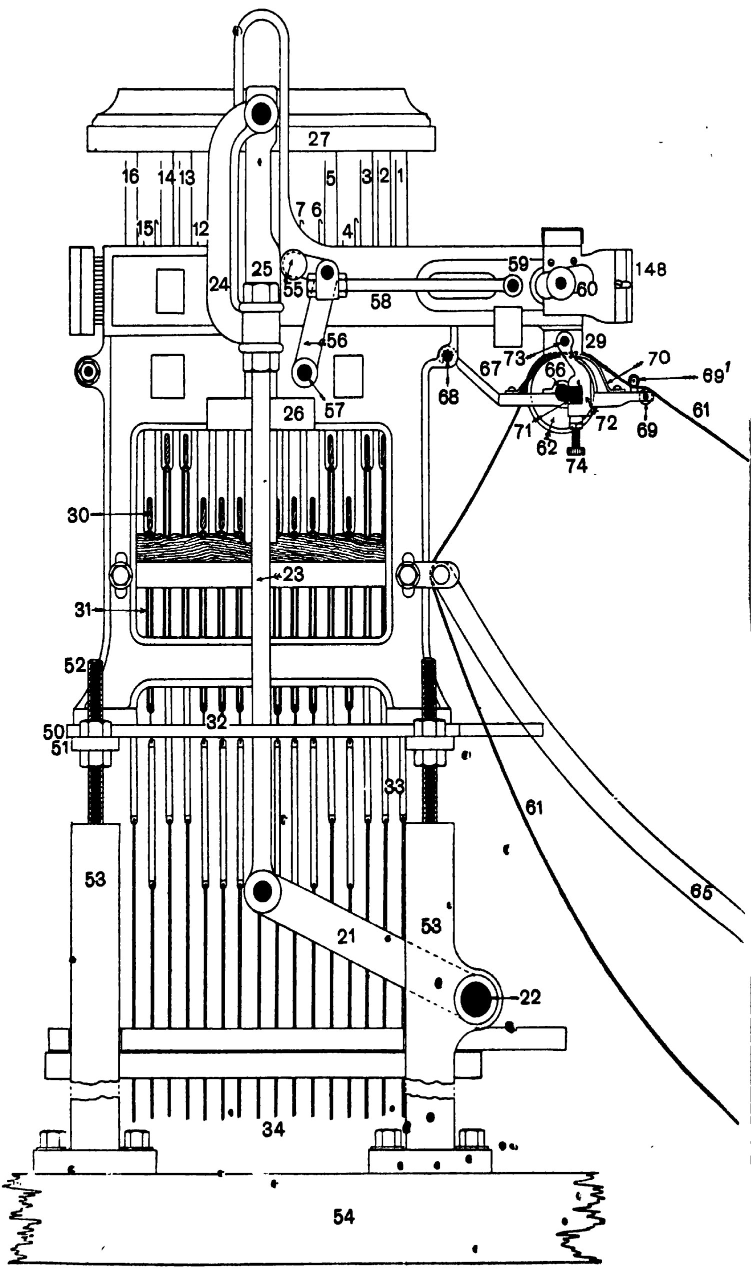
The above-mentioned duplicated parts are illustrated in Fig. 363, which is an enlarged view of the jacquard at the opposite side to the driving. The hooks or uprights shown are really those belonging to the last row of the machine, but they correspond to the positions of Nos. 1 to 16 at the other side of the machine, and have been marked as such. These hooks are operated in the usual way by horizontal needles, and need not be discussed here. They are placed in position, however, by a series of short vertical selector needles housed in the box 29.

An enlarged view of one of the hooks, say No. 1, appears in Fig. 364. A lath 30 passes between the two wires of each hook in a long row, and thus serves to keep the upper bends of all the hooks in that particular row facing the knives 28 and the cylinder. A twisted cord 31 is attached to the bottom bend of the hook or upright, and then a cord 32 (often a wire) joins the cord 31 to the weighted piece 33. Lastly, the cord 34 attached to the bottom of the weighted piece 33 is the usual harness cord, which stretches in this case direct to the lingoe 37, Fig. 362.

Each lingoe 37, Fig. 362, is connected to two cords: one cord, 34, passes, as stated, direct to the bottom bend of the hook in the jacquard; while the other cord, 38, is connected to the bend 39 of the wire Z fulcrumed at Y. (See the large detached view on the left of Fig. 362.) To the other end 40 of the wire Z is attached a cord 41, and this cord is under the influence of one of the front lingoes 42. There are intermediate parts between the end 40 of the wire Z and the lingoe 42, but these will be discussed in connection with further illustrations. In the meantime, it will be seen that all the back harness cords 34 pass between alternate pairs of glass rods 43, while the cords 38 from the end 39 of wire Z pass between the other alternate glass rods 43. All these glass rods are housed in the upper back heck 44, and the latter is supported by the brackets 45. The lingoes 37 pass between the iron rods 46 of the bottom back heck 47, which is held in position by the brackets 48.

From the parts illustrated in Fig. 362 it will be observed that when any hook 1 to 16, in the row illustrated, or in any other row in the jacquard, is lifted by the knife 28 to the high position indicated by the upper knife 28 in Fig. 364, the corresponding harness cord 34 and lingoe 37, Fig. 362, will be raised. Simultaneously, the cord 38 exhibits a tendency to become slack, and this slack is immediately taken up by the gravitational action of the front lingoe 42. This obviously causes the wire Z to rotate slightly counter-clockwise as the cord 41 and the lingoe 42 descend.

The jacquard itself, which is of the Verdol type, is represented in Fig. 362 by the dotted rectangle 49, and is supported as shown by two pairs of plates 50 and 51, at right angles to each other, and adjustably mounted for height on the screws 52 rising from four substantial brackets 53. Two


27
16
14
13
5
3
2
1
7
6
15
12
4
59
148
25
24
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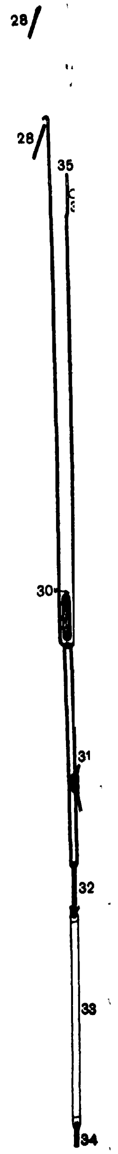
58
60
56
29
73
70
67
66
69¹
68
57
26
61
72
71
69
62
74
30
23
31
52
32
50
51
33
61
53
65
53
21
22
34
54

FIG. 363.

of the brackets 53 are provided with bearings for the heavy shaft 22. The whole is supported by the long back rails of the frame A and by the columns 54. Most of these parts appear on a larger scale in Fig. 363, and this view also shows that when the griffe 27 is raised the bulged portion of the slide 25 forces out the anti-friction bowl 55 of the lever 56 fulcrumed at 57. This action causes the rod 58 to push outwards the slide 59, which, in virtue of the oblique slot 60, causes the short vertical indicator needles in box 29 to be raised slightly in order, as well as in time, to allow clearance between the bottom ends of the vertical needles and the card or paper 61, when the latter is carried partially round by the movement of the cylinder 62.

The strip of paper 61, which has been punched in the fine-pitch piano machine according to the required design, and which therefore acts as the pilot set on the repeater, passes, as shown,



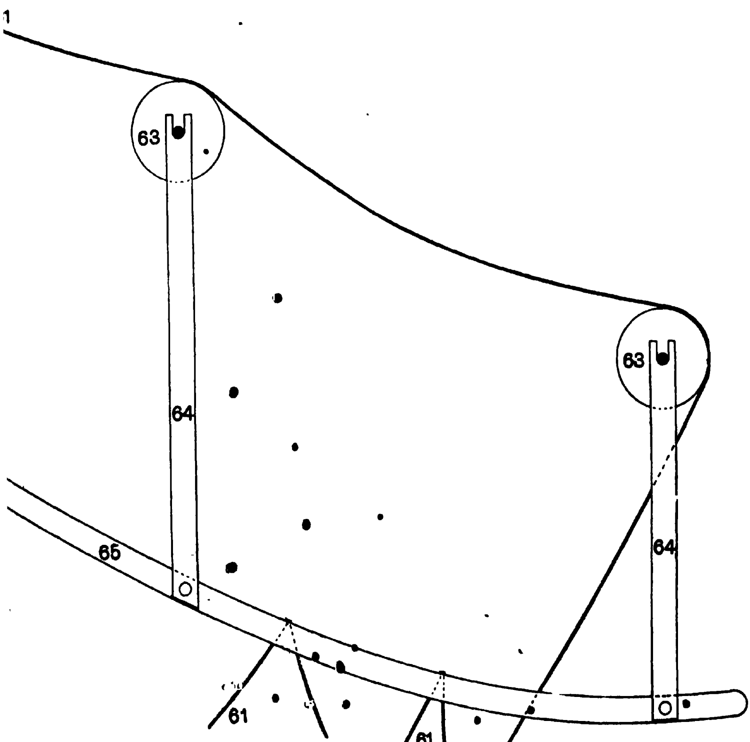


Fig. 363.

Fig. 364.

over the guide pulleys 63 supported in the slots in the upper ends of brackets 64. The lower ends of these brackets 64 are secured to the cradle 65.

In the general and enlarged view in Fig. 363 the cylinder 62 is in position with the vertical needles clear of the paper 61, but ready to pass through the holes or to be held up by the blanks or uncut portions immediately the griffe 27 descends.

The pivots 66 of the cylinder 62 rest in suitable bearings in the brackets 67, which are hooked as shown to the pins 68 in the jacquard frame. At the other end of the bracket 67 is a small roller 69 which acts as a guide for the paper strip 61 as the latter is approaching the cover 70 of the cylinder 62. At a point between the two ends of the bracket 67 is a projecting rectangular piece 71, while a corresponding recess is formed in the arm 72 fulcrumed loosely on a pin 73 which projects from the side of the needle box 29. When the rectangular piece 71 is within the recess of the arm 72, Fig. 365, it is held securely in that position by tightening the screw 74. After the repeating has been completed and it is desired to remove the pilot strip of paper 61 from the cylinder 62, the screw 74 is slackened and the arm 72 pulled to the right to sever the connection between the rectangular part 71 and the recess in the arm 72. When this is done, the bracket 67, with all its parts, may be placed in the position indicated in the lower part of Fig. 365, in virtue of the bracket 67 being free to rotate partially on the pin 68.

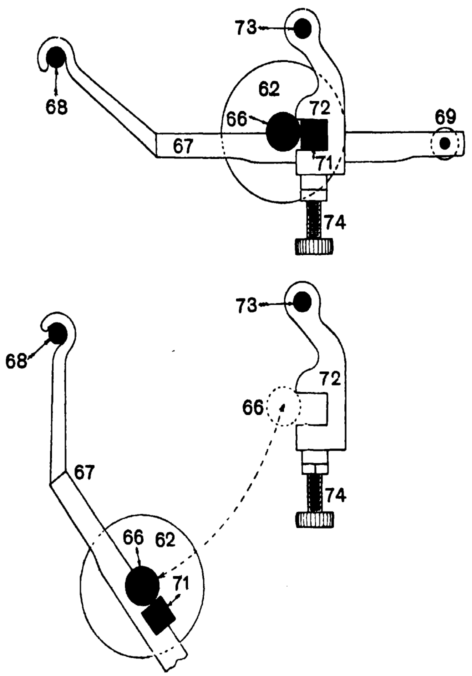


Fig. 365.

The paper strip to be cut, or repeated, as it is termed, is drawn forward

by the pins or pegs in the discs 75, Fig. 361. These discs 75 are spaced on the shaft 76, the shaft itself, as well as its companion 77, being rotated intermittently by the action of the sliding catches 78 on the wires of the squirrel cages 79.

The wires of the squirrel cages 79 are fixed in the discs 80 (see Fig. 367), and these, together with the driving discs 75 and the shafts 76 and 77, constitute the two cylinders which move, forwards or backwards, the strip of paper to be duplicated.

The shaft 81, Fig. 361, carries four short-hooked levers 82. To one end of each lever is a spiral spring (not shown), and cords pass from these

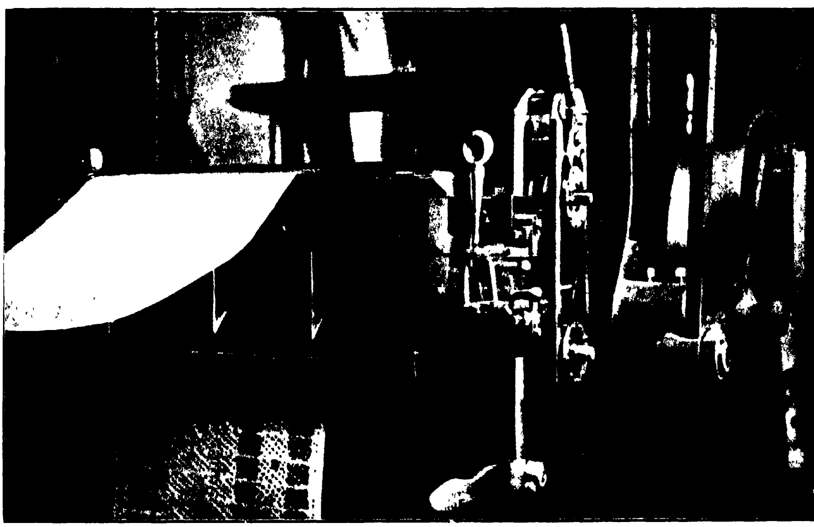


FIG. 366.

levers to place the punches for the peg-holes in or out of action. A lever fixed on the end of the shaft or rod 81 can be turned through approximately 90 degrees to rotate the rod into either the on or the off position.

The reproduction in Fig. 366 is a specially prepared photographical view, on a large scale, of the mechanism which operates the paper to be cut or repeated. The pilot set of cards—or, rather, the length of paper—cut on the fine-pitch piano machine, passes to the jacquard of the fine-pitch repeater, as indicated by the numbers 61 in Fig. 363. This fine-pitch jacquard of the repeater, as already pointed out, lifts the cords 34, Fig. 362, as well as the cords 38; this dual operation results in the lingoes 42 descending and placing in position the cords so that the repeating or copying

of the design on the pilot cards, or paper 61, Fig. 363, may be transferred, or, rather, repeated, on a new set of cards or paper. The exact way in which this latter operation is performed has not yet been explained, but the actual cutting or punching is performed immediately behind the mechanism illustrated in Fig. 366, or, rather, in the space behind and

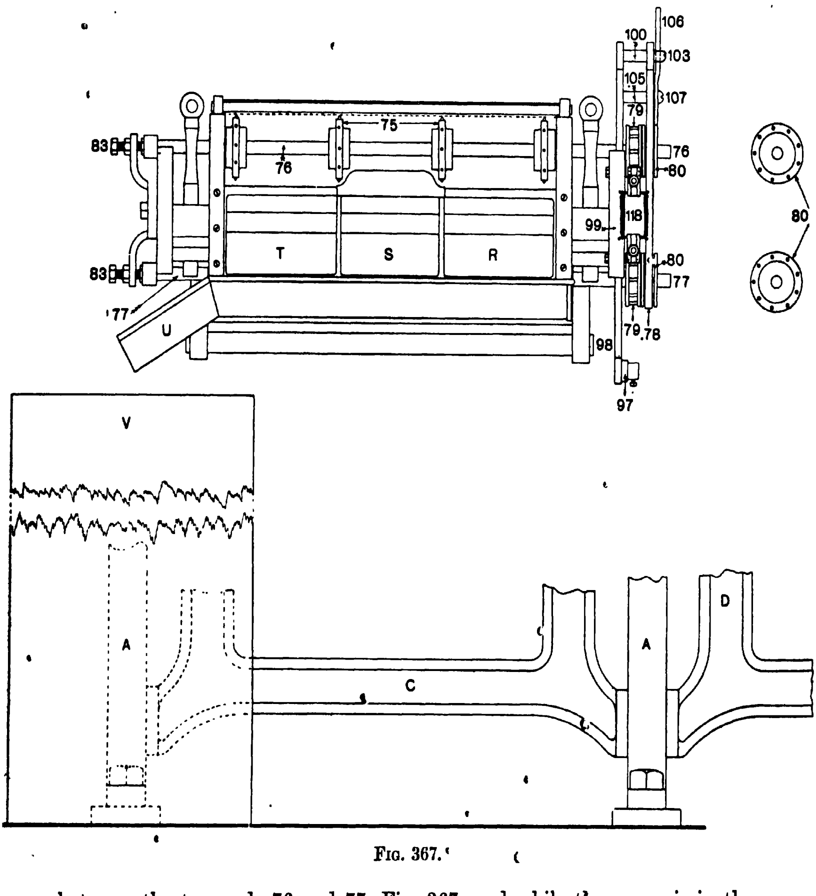


FIG. 367.

between the two rods 76 and 77, Fig. 367, and while the paper is in the vertical position.

It will be seen on referring to Fig. 366 that the horizontal or upper part of the paper is uncut, whereas that part which is descending from the lower part of the mechanism is perforated, and will be in the same order as the cutting on the paper which happens to be in work on the cylinder of the jacquard.

As previously mentioned, the small paper discs which are punched out of the paper sheet slide down the inclined planes R, S, and T, Fig. 367, and into the horizontal gutter or spout. (See Fig. 366, also for these parts.) The discs are periodically drawn forward by hand, and ultimately pass down the inclined gutter U into the box V. The box V is shown broken in Fig. 367 for the sake of space. The position of the rods 76 and 77, Fig. 367, can be adjusted laterally by means of the set-screws 83 and their lock-nuts.

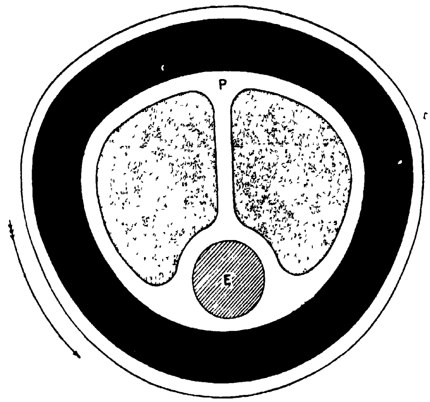


Fig 368.

At the other end of the rods 76 and 77 are the two squirrel cages (with their pins) 79; these have to be operated simultaneously by means of sliding catches, the back part of one of which is shown at 78. The method of operating these squirrel cages will be explained shortly; meanwhile, it will be seen that part of the cams P and Q, Fig. 361, is shown in Fig. 366. In addition, the bell-crank lever 18 and the rod 20, Fig. 361, are clearly visible in Fig. 366, and so is the spring N, Fig. 361. It will be remembered that it is this spring which acts on the clutch mechanism to stop the machine always at the same point of its angle or rotation.

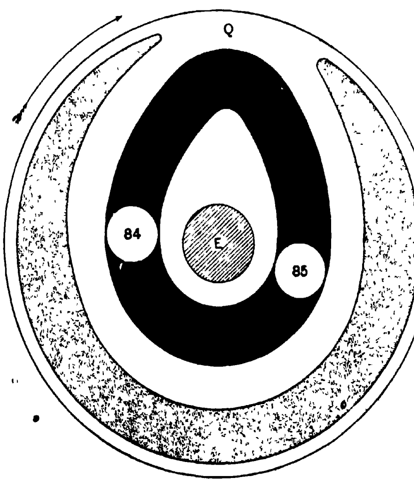


Fig. 369.

Special and enlarged views of these two cams P and Q are shown in Figs. 368 and 369, where the solid black parts represent the recessed cams which operate the anti-friction bowls and their levers. Although both cams revolve in the same direction, the cam P is viewed from the belt side of the

machine, whereas the cam Q is viewed from the other side of the machine. Hence, in Figs. 368 and 369 the directions of motion are counter-clockwise and clockwise respectively, as indicated by the arrows.

The position of the anti-friction bowl, which is operated by the cam P, is not shown in Fig. 368, but its position is plainly indicated by the number 17 in Fig. 360. Two anti-friction bowls are operated by the cam Q, Fig. 369, and the positions for these two anti-friction bowls are represented by numbers 84 and 85. The cam Q thus operates two different levers, one for moving the lever for the slide catches, and the other for moving the knife block or back heck, the part which operates the punches and so causes the latter to perforate the sheet of paper at the proper places.

The mechanism by which the punches are operated to perforate the paper is illustrated in Figs. 370 to 373. When the cam Q rotates clockwise, as indicated in Fig. 369,

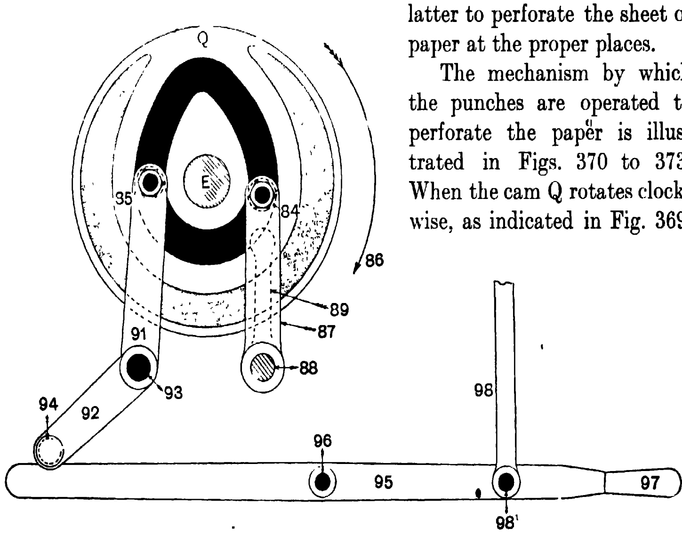


FIG. 370.

and when viewed from the frame side opposite the driving in Fig. 361, the box cam, shown in solid black, will force the anti-friction roller 84 to the right, Fig. 370, or towards the front of the machine, and will, in consequence, force the lever 87, fulcrumed on the rod 88, to the right. The rod 88 (see also Fig. 371) extends across the machine and carries two shorter levers, one only being shown at 89. The upper ends of these two levers 89 enter recesses in the knife block or back heck 90. The knife block is thus caused to move forward in its slides a short distance for each revolution of the cam Q. This movement effects the cutting of the paper—an operation which will be explained fully in connection with another drawing. Before describing this, however, it is advisable to explain that the same cam Q will, at a later moment of its rotation, also move

the anti-friction roller 85, Fig. 370, to the left. Hence, the levers 91 and 92, fulcrumed at 93, will cause the anti-friction roller 94 (see also plan view, Fig. 372) to act upon the left-hand end of lever 95, fulcrumed at 96. This lever is provided with a handle 97, which is clearly visible in the foreground of Fig. 366.

Referring now to Fig. 373, which is a detailed view of the corresponding parts in the foreground of Fig. 366, and viewed from the pulley side of the machine, it will be observed that the handle 97 of the lever 95 is placed similarly to the same part in Fig. 366, but at the opposite end to what obtains in Fig. 370. The lever 95 in Fig. 373 is shown only to a point a little beyond its fulcrum 96, but a full view is exhibited in Figs. 370 and 372. When the cam Q, Fig. 370, has made approximately half a revolution from its present position, it will impart movement to the levers 91 and 92, through the anti-friction bowl 85, and hence the left-hand end of lever 95 will be forced downwards and its right-hand part raised. Consequently, the flat rod 98, attached at 98^1 to lever 95, will be raised through a certain distance, and then brought back to the position indicated in the figure. Part only of the flat rod 98 is illustrated in Fig. 370; the function performed by it will be understood by reference to Figs. 366 and 373.

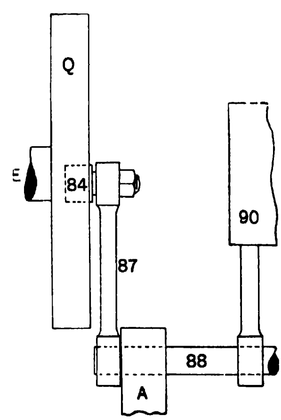


Fig. 371.

The flat rod 98, Fig. 373, moves vertically under the influence of the above-mentioned parts in the slides 99. At the upper end of the flat rod 98 (see Figs. 366 and 367) is fixed a stud 100, and upon its reduced end supports, swingingly, the two catches 78 and 78^1 (see Fig. 373). A brass plate 101 is fixed by screws 102 to the upper part or bridge-piece of the two catches 78 and 78^1, and from this brass plate 101 project two pins 103 and 104. A centre projection depends from the bridge-piece of the two flat rods 98, this depending piece being visible only in Fig. 366. A second stud 105, Fig. 367, is fixed to this depending piece, as shown in Fig. 366, and projects between the upper parts of the two arms of the catches 78 and 78^1. Upon the end of this stud 105 is placed the handle 106, Fig. 373, and held in position by the screw 107. This handle 106 is used to determine which of the two catches 78 or 78^1 shall act upon the pins 79, Fig. 367, of the squirrel cages or cylinders, the end-plates or discs 80 of which are adjustable, as shown in Fig. 373, by means of the slots 108

and the screws 109. A small flat spring 110 is secured by its upper part to the handle 106, while the inner side of the flat spring 110 is provided with a small dome-shaped projection adapted to enter into any one of the three small recesses 111, and so hold the handle 106 for the time being securely in any of the three positions.

The dome-shaped projection of the flat spring 110 is at present in the left-hand recess, with the handle 106 resting against the stop-pin 103. When the handle 106 is in this position, the right-hand lobe at the bottom and broad part of the handle keeps the right-hand catch 78^1 clear of the pins 79 of the cylinder in virtue of the hump 112, and at the same time the left-hand lobe of the broad part of handle 106 allows the left-hand catch 78 to come into play against the pins 79. It will thus be seen that when the flat rod 98 is raised as explained, the two projecting parts of the catch 78 will simultaneously take hold of two pins 79, one in each cylinder, and rotate the cylinders one-ninth of a revolution

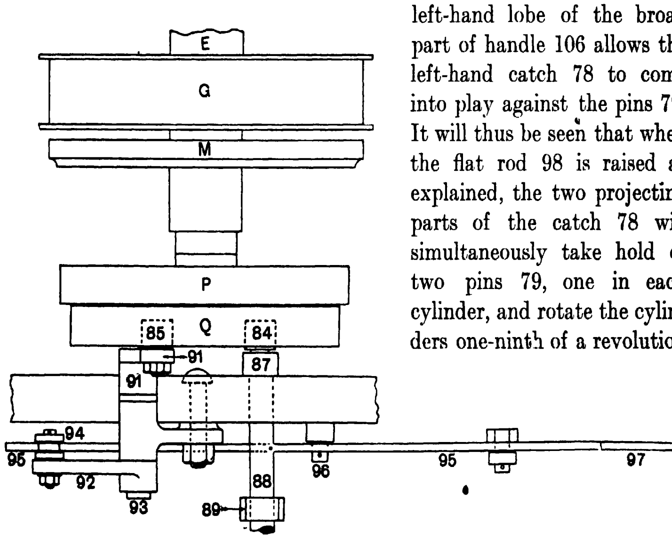


FIG. 372.

clockwise. This movement on the part of the two cylinders will draw forward the paper sheet, Fig. 366, a distance equal to the pitch of the cards, or, rather, the paper-strip equivalent of a card.

When the handle 106 is in the vertical position, as indicated by the dotted outline of the handle in Fig. 373, both catches are out of action. If, for any purpose, it is desired to reverse the direction of the paper, this may be done by placing the handle 106 in the right-hand position and against the stop-pin 104. The two catches 78 and 78^1 are joined by a spiral spring 113, which brings the active catch for the time being into position after it has been forced outwards during its downward movement by the pins 79.

Two bell-crank levers 114 and 115 (see also Fig. 366), fulcrumed respectively at 116 and 117, have the ends of their long arms joined by a

spiral spring 118. Rods 119 and 120 are attached by nuts to the bell-crank levers 114 and 115, and their forked ends 121 and 122 support, by means of pins, the bowls 123 and 124. These bowls rest between two of the pins 79, and serve as spring hammers to keep the two cylinders per-

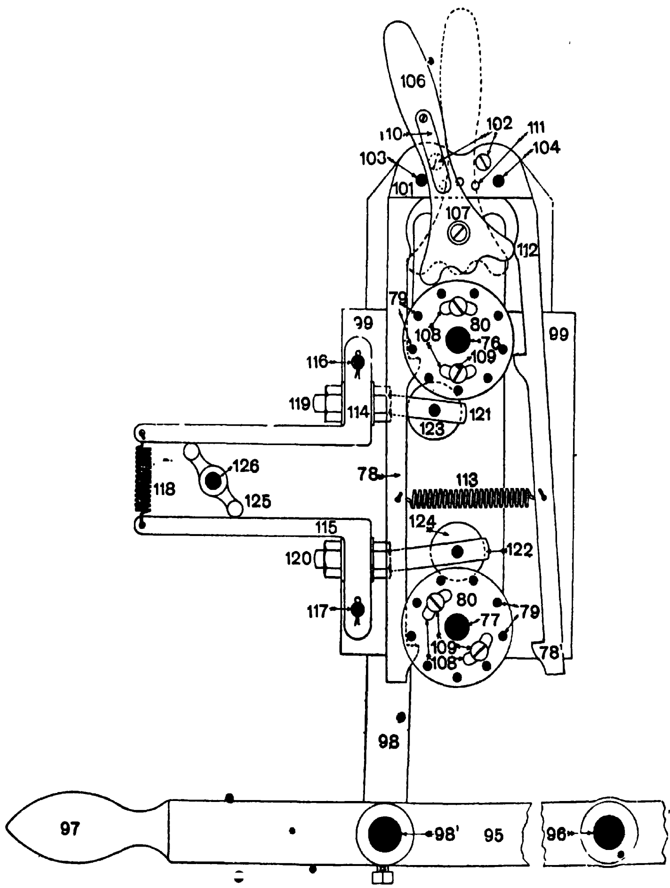


FIG. 373.

fectly stationary after they have been partially rotated as described. If, however, the short lever 125, fulcrumed at 126, be placed vertically, the long arms of the bell-crank levers 114 and 115 will be moved up and down respectively, extending the spring 118, while the short arms of levers 114 and 115 will be moved towards each other so as to withdraw the bowls 123

and 124 from contact with the pins 79, in which case the two cylinders may be rotated quite easily and thus enable the operator to withdraw the paper or move it forward quickly. Slight adjustments of the paper strip on the cylinders, in either direction, may be effected by means of the handle 97, Figs. 366, 370, and 373, provided that the proper catch 78 or 78^1 be placed into the active position.

The squirrel cages or cylinders are in duplicate, as illustrated in Figs. 366 and 367 ; the pins 79 of the outside pair are acted upon by the catches

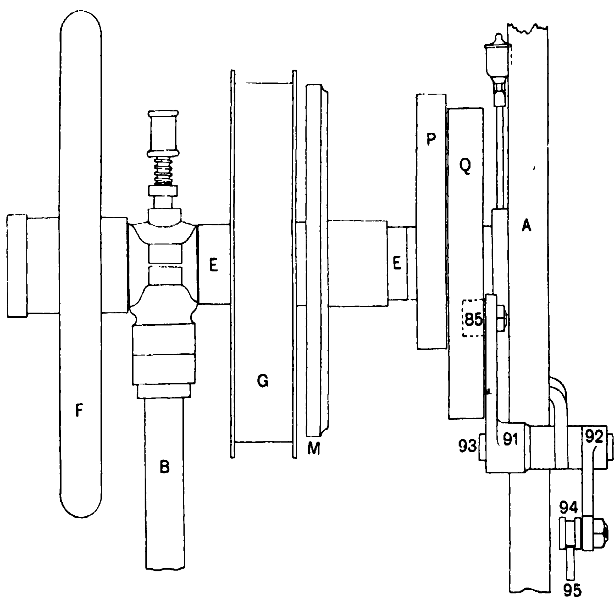


FIG. 374.

78 and 78^1, while the pins of the inside pair work in conjunction with the rollers 123 and 124, Fig. 373, of the spring hammers.

Fig. 374 illustrates the chief parts of the driving mechanism as viewed from the back of the machine ; it also shows the positions of the two main cams P and Q, Figs. 368 and 369, and the back levers from the latter which operate the lever 95 fully illustrated in Figs. 370, 372, and 373.

Further details of the cams P and Q and their connections to the various levers appear in the plan view in Fig. 375. This view also shows the plan view of the peg wheels 75 with their covers, the front comberboard W, and a part of the back comberboard 44. The three large numbers 448 in the three divisions of the comberboard W show that the total capacity

of the machine is 448 × 3 = 1344 cords; while the disposition of the holes in the comberboard is exhibited partly by two front and two back short rows of eight, and the complete front and back long rows.

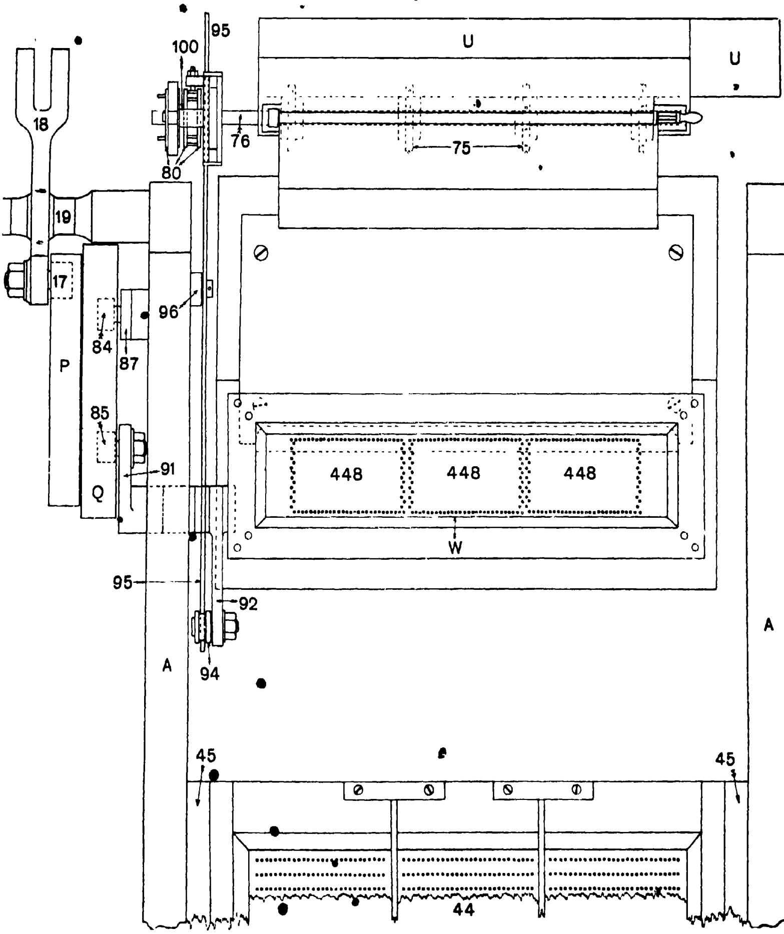


FIG. 375.

The holes in the front comberboard W are staggered as shown, whereas the holes in the back comberboard 44 are in straight rows in both directions. Between each pair of long rows in the back comberboard 44 is a glass rod (see 43, Fig. 376 and Fig. 362). In Fig. 376 a small part only of the comberboard 44 is shown, while immediately above this plan view is an elevation

of the back of the comberboard 44 with the parts 127 and 128 which serve as supports for the series of glass rods 43. This view also exhibits the arrangement for supporting the bottom heck 46 and 47, the latter heck being used as a guide for the flat lingoes (see Fig. 362).

We shall now illustrate the method of operating the punches which pierce the paper strip illustrated on the left of Fig. 366. It has already been shown in Fig. 362 that the cords 41 pass through the front comberboard W, and that the lingoes 42 are attached to their lower ends. The comberboard W is reproduced on a larger scale in Fig. 377, and sixteen cords 41 descend to the lingoes 42, part of the length only of which is illustrated.

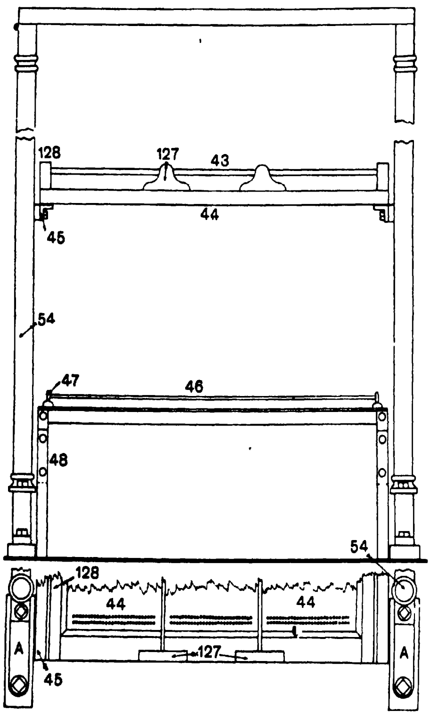


FIG. 376.

Eight of the cords 41, Fig. 377, are shown in rope form, and eight are in line work; this distinction is to show that the cords form two of the staggered rows (see plan view, Fig. 375); they are also drawn much thicker than they actually are. The harness cords 41 pass between two brass plates 129 and 130. Each of these plates contains as many holes as there are harness cords 41 in the comberboard W—*i.e.* 1344—and the disposition of the holes in the plates 129 and 130 is exemplified by four complete rows in each case in Fig. 378. The two plates are secured to the block 131 (see Fig. 379), and this block, in conjunction with a similar block at the opposite side of the machine, provides the slides for the sliding blocks 132.

The back parts of the sliding blocks 132 are held by the knife block or back heck 90, Fig. 377, and may be adjusted to position, horizontally and vertically, by the screws and lock-nuts. At the front of the sliding blocks

132 is the needle plate 133, the function of which will be explained shortly. Part of the rear of the back heck 90 is shown in Fig. 380.

The two sliding blocks 132 and the back heck 90, Fig. 377, are moved

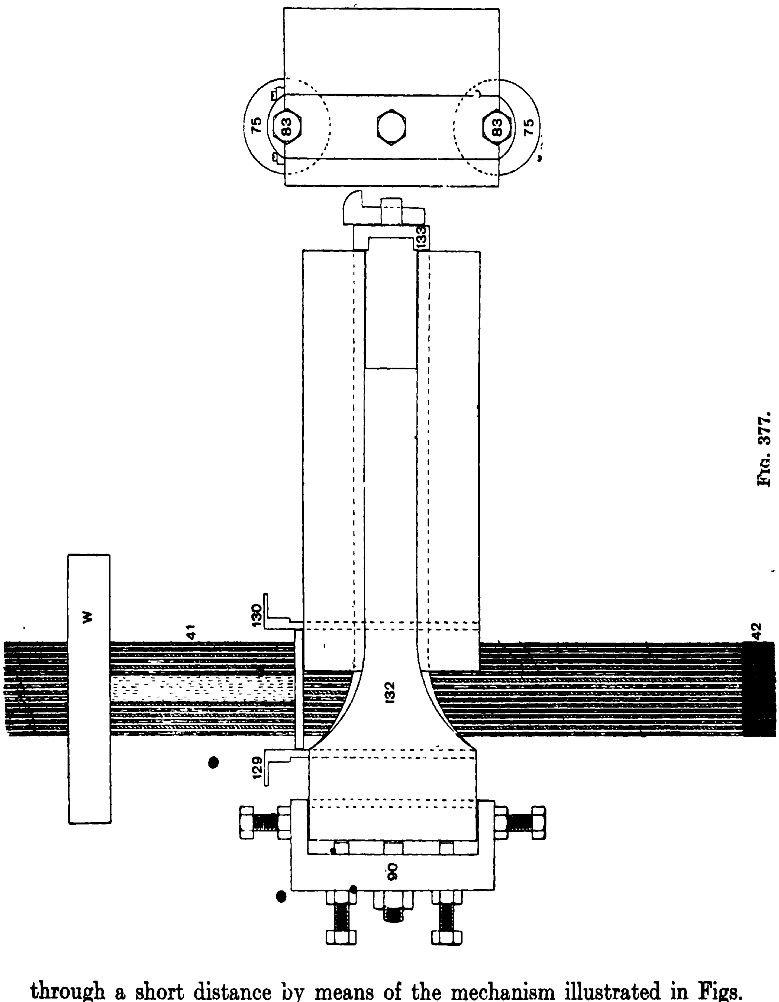


FIG. 377.

through a short distance by means of the mechanism illustrated in Figs. 370, 371, and 372. The upper part of the short lever 89 enters a recess in the knife block or back heck 90, so that as the cam Q rotates as indicated by the arrow the back heck 90, Fig. 377, is first moved to the right and then back again. These two motions obviously take place every revolu-

tion of the cam Q, Fig. 370. The knife block or back heck 90, Fig. 377, is shown in section in Figs. 381 and 382, but the adjusting screws are omitted. It will be seen that there are 16 short knives 134, the outer end of each of which has a <-shaped recess. Sixteen punch needles 135 are bent as shown, and their extreme left-hand ends are <-shaped. The extreme right-hand ends of the punch needles 135 are supported by the

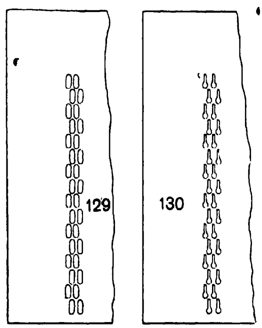


FIG. 378.

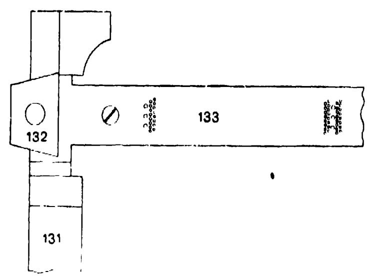


FIG. 379

needle plate 133, while the left-hand ends are supported by the brass plates 129 and 130. The punch needles 135 are kept in their proper positions by the slots above the holes in plate 130, Fig. 378.

If the punch needles occupy the positions indicated in Fig. 381, the short knives 134, when carried forward by the back heck 90, will push the punch needles 135 to the right. Eight of the punch needles 135 are shown complete in this figure, but the remaining eight are cut off because of the difficulty of illustrating all the sixteen in the needle plate 133.

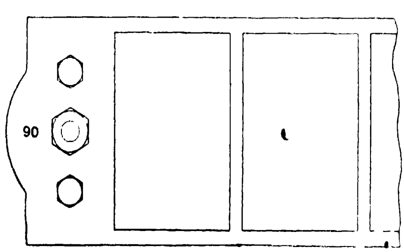


FIG. 380.

The actual punches 136 are located in the plates 137, and the small ends of the punch needles 135 are exactly opposite the heads of the actual punches 136, while the paper strip 138 to be cut passes between the right-hand plate 137 and the punch plate 139.

In Fig. 382 the <-shaped ends of two punch needles 135 occupy positions opposite the spaces between the knives 134, while the three lower punch needles are opposite the <-shaped ends of the knives 134. The

knife block 90 is supposed to have moved to the right until the knives 134 and the punch needles 135 are almost in contact. Any further movement of the knife block and knives to the right will cause the lower three punch

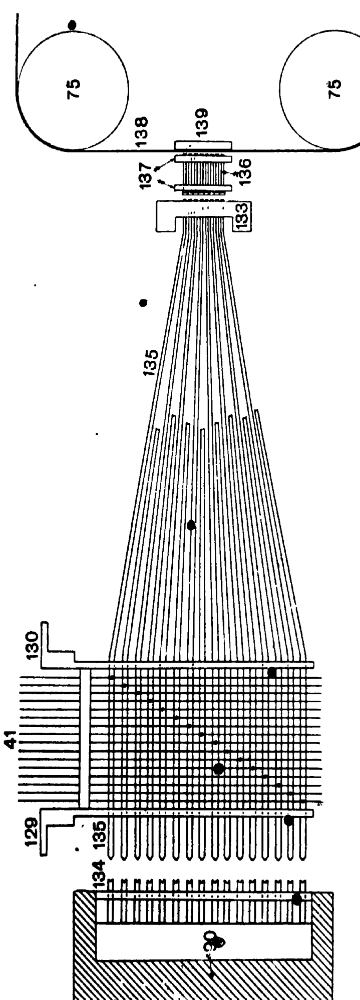


FIG. 381.

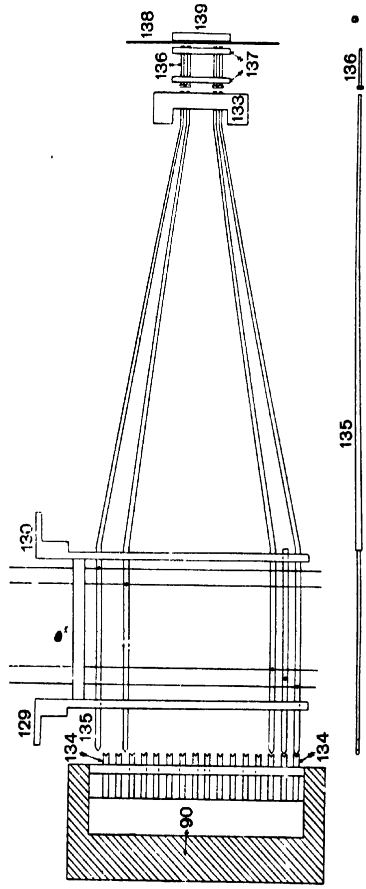


FIG. 382.

needles to be pushed to the right, and their small right-hand ends would, consequently, push forward the actual punches 136, the cutting ends of which would pass through the paper strip 138 and into the fixed punch plate 139.

The left-hand ends of the two upper punch needles 135 would, simultaneously, enter between the knives 134, and these two punch needles would remain undisturbed, and so would their respective actual punches 136. It will thus be clear that the paper strip 138 would be cut at those points represented by the sliding movement of the punch needles 135, whereas blank or uncut portions of the paper strip would appear opposite those punch needles which are not actuated by the knives 134. A plan view of one of the punch needles 135 is shown detached at the bottom of Fig. 382.

The action of the selecting mechanism is as follows: The pilot paper 61, Fig. 363, effects the selection of the vertical needles of the Verdol jacquard, so that all hooks actuated by the horizontal needles of the jacquard, due to the selective agency of the short vertical needles, will be raised or left down according to whether holes or blanks appear on the pilot paper 61. Those hooks which are raised, due to holes in the pilot

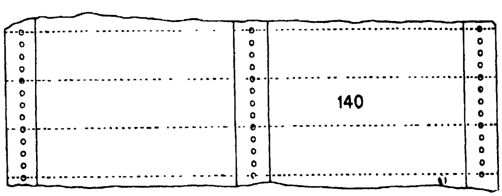


FIG. 383.

paper, raise the corresponding harness cords 34 (see Fig. 362), together with their lingoes 37. The upward movement of a lingoe 34 enables the corresponding lingoe 42 to descend and to take up the slack harness 38 as demonstrated. Hence, the harness cord 41, Figs. 377 and 381, would descend.

In Fig. 381 it is assumed that all the cords 41 illustrated have descended to their lowest position, and that this action was due to the fact that two rows of eight, or sixteen holes in all, appeared in the pilot paper 61, Fig. 363, and that consequently, when the corresponding 16 harness cords 34 were raised, the 16 harness cords 41, Figs. 362 and 381, would descend, because the upper and lower stretches of harness cords are attached to the punch needles 135, a hole being left in the needle purposely to enable the harness cords to be attached to the punch needle. When the 16 harness cords 41 descend, the <-shaped ends of all the 16 punch needles 135 will descend and occupy the position as illustrated immediately opposite the <-shaped ends of the knives 134. Under such conditions, all the 16 punches would be pushed to the right, and 16 actual punches 136 would

be forced through the paper strip 138, so that the repeated paper would be identical with the pilot paper 61 in these two rows, and, of course, in all the other rows according to the blanks and holes in the pilot set.

When the paper strip is placed on the pegs of the cylinders 75 it contains peg-holes which correspond to those which the dotted lines cross in the paper strip 140, Fig. 383. These holes are necessary to enable the uncut paper strip to be carried intermittently forwards or backwards, as the case may be, by the catches 78, Fig. 373.

Special punches, similar to that shown at 141, Fig. 384, have three punches which are utilised to punch three successive holes in each of the three reinforced strips of each card equivalent. These three holes, or nine altogether in each card section, are cut simultaneously with the holes for the design. It will be understood that three of these triple punches 141 are always in position for two of the knives 134, Fig. 381, to push the punches forward for every card. If for any reason the triple punches are required to be out of action, they may be raised so that the two <-shaped prongs on the left of 141, Fig. 384, may enter between the

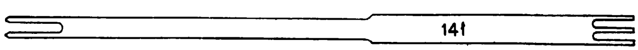


FIG. 384.

knives 134, Fig. 381. This withdrawal of the triple punches is accomplished by the parts 81 and 82, Fig. 361.

One of the latest fine-pitch repeating machines for endless paper cards is that illustrated in Fig. 385. It occupies much less space than the machine just described, and has the distinct advantage of being without harness cords of any kind.

The pilot set of cards, or, rather, endless paper, is cut as usual on the fine-pitch piano machine. The paper strip upon which the duplication has to be made is shown at 138, Fig. 386. This part of the machine is practically identical with the corresponding part in the foregoing machine, and the method by means of which the operation is performed is demonstrated in the sectional view of the chief parts in Fig. 386.

The pilot endless strip of paper 61, instead of being placed over the cylinder 62 and the cover 70 of a fine-pitch jacquard, as in Fig. 363, is passed over a similar cylinder 62, Fig. 386. In the latter case, however, the cylinder not only rotates, but is raised and lowered for each card equivalent. The paper strip is held in position by the usual pegs on the cylinder 62, and passes over the cover plate 70 so as to clear the ends of the vertical needles 142. Two vertical needles only are shown, but it will be understood that there are 16 in two staggered rows to correspond with

the cards, etc. Each vertical needle 142 controls a horizontal presser rod 143, the right-hand end of which is provided with a head to come, when required, into contact with the left-hand end of its corresponding punch needle 135. The right-hand ends of the punch needles are adapted, when moved, to strike the heads of the actual punches 136, and to force

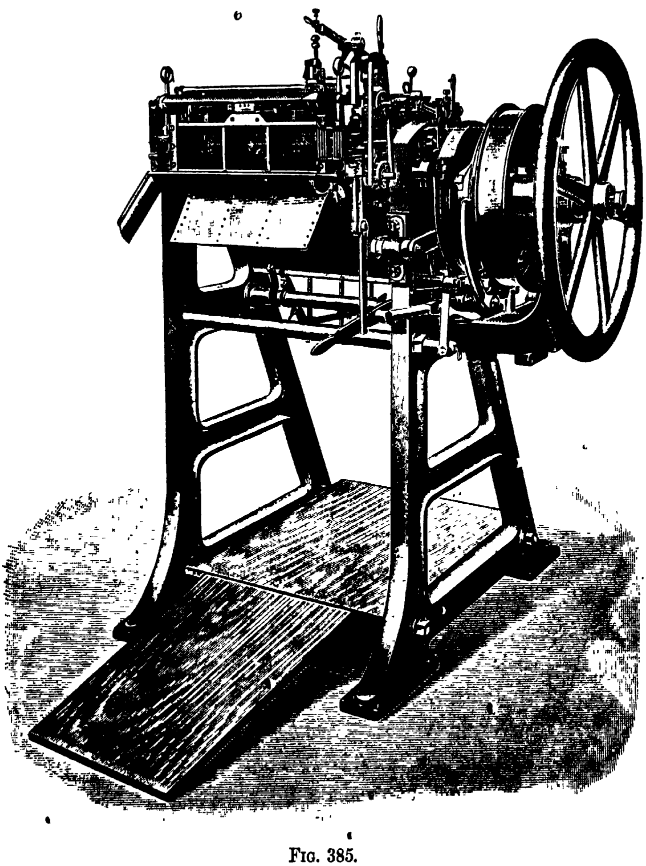


FIG. 385.

them through the paper strip 138 which is in process of being duplicated according to the holes and blanks in the pilot paper strip 61.

As illustrated in Fig. 386, the vertical needles 142 are in their lowest positions, being supported in that position for the time being by the hooks at their upper ends and the hook-rest 144. When the cylinder 62 has been turned to place a new card equivalent under the lower ends of the vertical

needles 142, the cylinder 62 and paper 61 are raised until the card equivalent of the paper is gripped between the cover 70 and the grid 145.

If two holes in the pilot card happened to be opposite the two vertical needles 142, illustrated in Fig. 386, the ends of the vertical needles would pass through the holes in the card 61, and the vertical needles would remain undisturbed. Then, when the back heck 90 with its knives 134 was forced to the right, the knives 134 would push forward the presser rods 143, and the heads of the latter would, in turn, push forward the punch needles 135, and ultimately the actual punches 136 would be forced through the paper strip 138 and into the holes of the punch-plate 139.

If, on the other hand, blanks in the paper strip 61 appeared under the lower ends of the vertical needles 142, the latter would be raised, and their

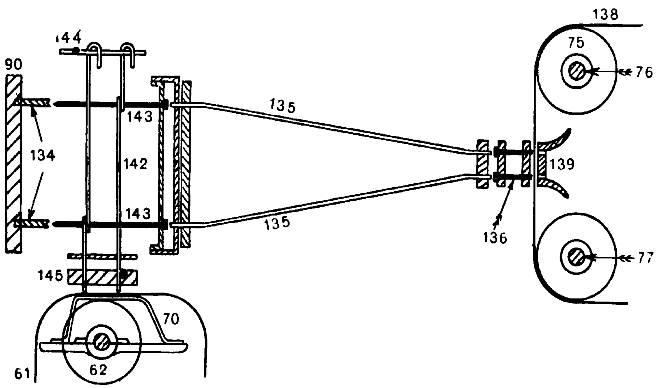


FIG. 386.

loops or bends would raise the left-hand ends of the presser rods 143 and thus would take them out of the path of the knives 134 as the latter were advancing.

A considerable number of designs which are prepared for the fine-pitch repeating machines, and also by the fine-pitch piano card-cutting machine, are intended for the twilling jacquard looms. As a matter of fact, fine-pitch jacquard machines are rarely used unless the unit pattern contains a very high number of threads. It need hardly be said, however, that the use of these fine-pitch machines always means economy at least in the weight of paper used. But, speaking generally, the designs on 200 to 600 hooks and needles are produced most largely in these islands by means of the ordinary-pitch, *i.e.* British-pitch, jacquards. The development of patterns on, say, 1800 to 2400 needles by British pitch machines means a considerable outlay in paper cards; and if the twilling jacquards were not used for such patterns, the outlay would be enormous,

and probably prohibitive for the bulk of these high-class figured textile fabrics.

For the flat treatment of designs, say damasks woven in twilling jacquard looms, there need not be any weave inserted on the design paper; hence, the cutting is comparatively simple, and so is the repeating. On the other hand, the weaves which can be used, and inserted mechanically by the twilling jacquard, are limited, and really restricted to two, unless some slight mechanical alteration is made in the machine itself.

In the silk trade it might be advisable to use a certain fixed type of ornamentation on a number of different fabrics, and in each case to alter the weave in the figure as well as the weave in the ground. Where such treatment is anticipated or desired, a machine similar to that illustrated in Fig. 387 would probably be useful. In general appearance this machine appears very similar to that illustrated in Figs. 357 and 358; while the jacquard on the right of the machine in Fig. 387 is identical with that in Figs. 357 and 358, and shown independently in Figs. 359 and 363.

There is only one jacquard in the machine illustrated in Figs. 357 to 363, but in Fig. 387 there are two jacquards mounted on the framework and connected by harness cords, as shown, to the lower parts of the repeater. The left-hand machine is a 600's coarse-pitch jacquard.

The two jacquards in Fig. 387 may work in unison, as will be explained shortly, or they may work separately. Thus, if an endless set of paper cards, which has been punched on the fine-pitch piano machine, required to be copied or repeated, the endless set would be placed over the cylinder of the fine-pitch jacquard on the right. The machine would then be started and the repeating process would be identical with that described in connection with Fig. 362. If, however, it is desired to make a fine-pitch endless paper duplication of a set of ordinary 600's jacquard cards, the latter are placed over the 4-sided cylinder of the coarse-pitch jacquard on the left of Fig. 387. The harness cords from this machine are attached to the lingoes in the large frame, and hence, when they are lifted, the oblique cords would be lifted as well, or rather slackened, and the front punches would take up this slack and thus place the cutting or punching apparatus into the desired position for duplication on the endless-paper cards.

The machine in Fig. 387 is thus capable of repeating fine-pitch sets of paper either from a similar fine-pitch set or from an ordinary coarse-pitch set. And, if necessary, a third machine, say a medium-pitch machine of the Vincenzi type, could be placed alongside the two in Fig. 387, and then fine-pitch duplications could be made from any of the three distinct sets mentioned, or from any other pitches, provided that the corresponding jacquards were mounted on the frame of the repeater.

But to return to our first consideration of endless-paper cards cut from designs on which no weaves occur, but which are composed of solid-painted masses and unpainted areas. This endless-paper set of cards could, naturally, be used as a pilot set for duplication by placing it, as already mentioned, on the cylinder of the right-hand jacquard in Fig. 387.

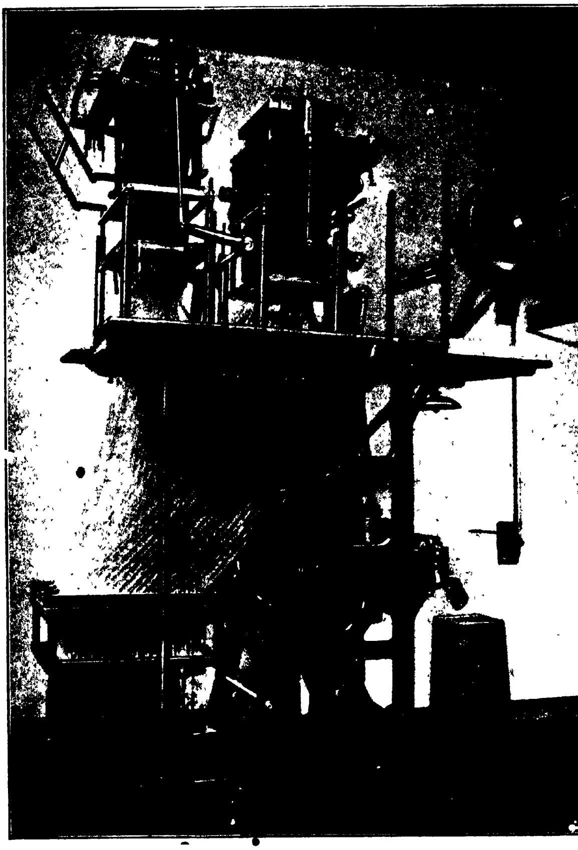


FIG 387.

The resulting set would be suitable for a twilling jacquard loom weaving common harness damasks, for certain kinds of quilts if a fine-pitch machine could be adapted for such work, and for similar fabrics where the weaves are inserted into the cloth by special mechanism or apparatus independently of the jacquard cards.

In addition to its faculty for the above work, the repeating machine

illustrated in Fig. 387 is adapted for producing full-harness designs on an endless sheet from a similar endless sheet which has been punched from a weaveless point-paper design.

Fig. 388 is a sectional and partly diagrammatic view of the essential cords, lingoes, etc., in the machine illustrated in Fig. 387. In the former figure several of the parts are practically identical with the corresponding parts of the Verdol fine-pitch repeater, and particularly with reference to Fig. 362 and Figs. 377 to 384. The extra parts which appear in Fig. 388 are the diagrammatic indication of a coarse-pitch jacquard on the upper left-hand side of the illustration, and the looped cords below the back heck 44. The back lingoes in Fig. 388 are marked 37^1, instead of 37 as in Fig. 362; but this is because the former fulfil a more extended function than the latter. The dotted area between the top and bottom front comberboards W and W^1 represents the right-hand ends of the punch needles 135, which in reality taper, as shown in Fig. 381, but in the opposite direction, towards the needle plate 133, in order to occupy the narrow limits at the points where the latter pierce the paper strip 138.

The object desired in the machine and diagram illustrated in Figs. 387 and 388 is to cause the vertical harness cords 41 to fall a short distance only when both cords 146 and 34 are raised by the two jacquards. This is accomplished by the method of connecting the cords to the bottom lingoes 37^1. In the somewhat similar arrangement for the Verdol fine-pitch repeater (see Fig. 362) it will be found that there are only 16 back lingoes in a short row; in Fig. 388, however, there are 32 back lingoes. For each group of three cords, 38, 146, and 34, Fig. 388, there are two back lingoes 37^1.

The arrangement of all the cords to the necessary parts is shown in full in Fig. 388; but in virtue of the necessary photographic reduction it will be difficult to follow all the parts distinctly, and especially those below the back heck 44. Hence a much-enlarged view of one group of cords, with the diagrammatic attachments, is introduced in Fig. 389. These three cords, 38, 146, and 34, are distinguished in the latter view by different kinds of markings, and part only of the length of each lingoe 37^1 is shown.

It will be seen that the central cord 38, Fig. 389, is attached to a ring 147, and passes upwards through the back heck 44, between the glass rods 43, and then direct to the end 39, Fig. 388, of the wire link Z in the frame X. The two cords 146 and 34 are shown as passing through holes in the upper parts of the back lingoes 37^1, Fig. 389. In reality the cords will be tied to the lingoes. A second and shorter cord from each, and distinguished by the same markings, is also tied or hooked to the back lingoes 37^1 and to the ring 147.

If either cord 34 or 146, Figs. 388 and 389, be raised alone, it has no effect upon the vertical movement of the ring 147; but if both cords 34

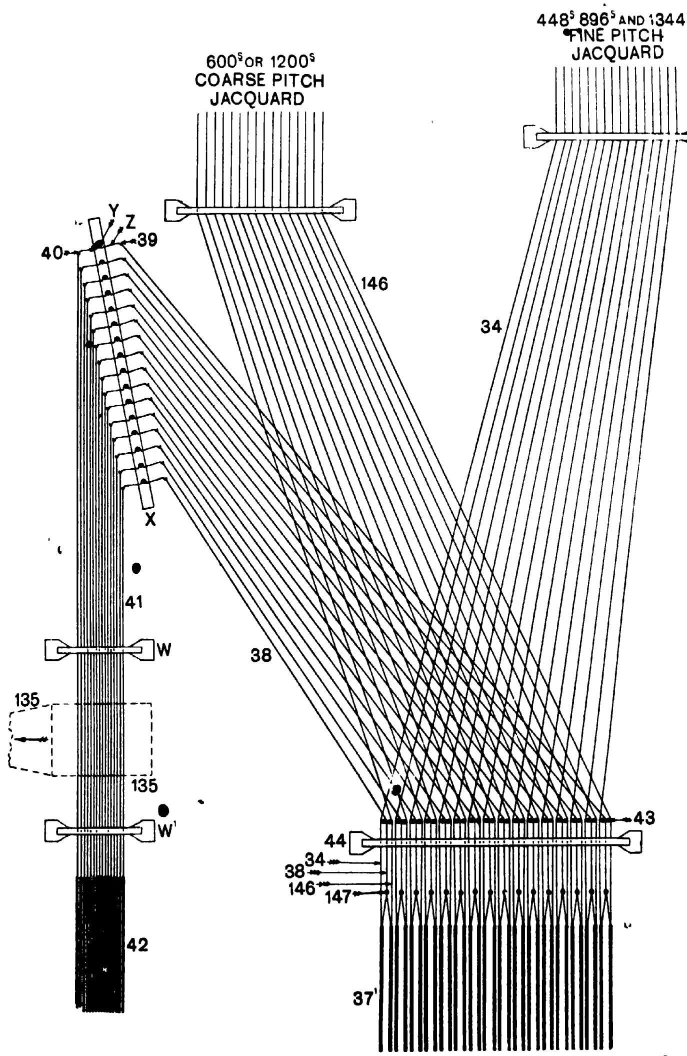


Fig. 388.

and 146 be raised simultaneously, the cord 38 and the ring 147 will be slackened, due to the raising of two adjoining back lingoes 37^1, and hence

the corresponding front lingoe 42, Fig. 388, will descend to take up the slack in cord 38, and will thus lower slightly the corresponding punch needle 135, so that its >-shaped end (<-shaped in Fig. 381) will be placed in the path of the moving grid 134.

It will be understood that arrangements must be made for the same number of cords in the group 146 as in the group 34, otherwise the two machines could not work satisfactorily. It does not follow that the two jacquards should have the same number of hooks, but it is clear that, whatever kind of repeating is done, it must be accomplished without break of pattern or break of weave.

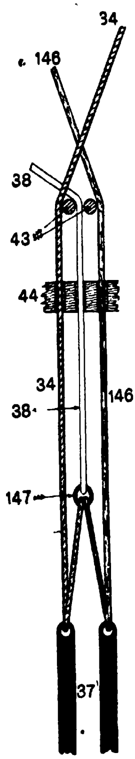


Fig. 389.

Suppose, then, that a design, to all appearances a common-harness design, has been punched on the fine-pitch repeating machine, the endless-paper cards cut from this design can be used for the purpose of duplication. If, however, a full-harness design of precisely the same ornamentation and number of needles (not hooks) were required, the endless-paper cards for this full-harness design could be punched on the repeating machine illustrated in Figs. 387 and 388 by the aid of the common-harness endless-paper cards.

The common-harness endless-paper cards would be placed on the circular cylinder of the fine-pitch jacquard on the right in Figs. 387 and 388, and this endless set would control the actual ornamentation according to the design; the weaves, however, which are necessary for the full-harness design would be introduced on to the full-harness endless-paper cards by means of the coarse-pitch jacquard on the left in Figs. 388 and 387.

Suppose, for example, that in the full-harness set it were desired to have the 5-thread sateen weave in the ground of the design, and the 8-thread sateen for the figure of the design. A set of cards punched with the $\frac{7}{1}$ sateen weave is placed on the four-sided cylinder of the coarse-pitch jacquard. Since the figured portion on the common-harness endless-paper cards is in more or less large areas, it follows that every hook in the figure portion in the fine-pitch jacquard will be lifted; simultaneously, seven hooks out of every eight of those in the coarse-pitch jacquard will be lifted; hence, every eighth cord 146, Figs. 388 and 389, will be left down. And, although the corresponding cord 34 is raised by the fine-pitch jacquard, the corresponding cord 38 will not be raised. Consequently, seven holes will be cut and the next place uncut on the endless paper

which is being repeated. The full length of the paper will be treated until the last card of the common-harness design has been repeated as a full-harness design, so far as the figure portion is concerned.

It now remains to introduce the 5-thread sateen, $\frac{1}{4}$, into the ground or unpainted area. The common-harness endless-paper cards which have been used as a pilot set on the fine-pitch jacquard in Fig. 388, and the repeated endless-paper cards, are now reeled back until each is placed with No. 1 pick opposite the needles and punches respectively. Then a set of coarse-pitch cards punched with the $\frac{1}{4}$ sateen weave is placed on the cylinder of the coarse-pitch jacquard; but before the operation can be completed, it is necessary to cause the ordinary needles of the fine-pitch jacquard to work negatively instead of positively.

When the jacquard is working positively—*i.e.* normally—the hooks 1, 2, Fig. 390, are under the control of the ordinary jacquard needles 146. The latter, however, are not acted on directly by the cards as in the ordinary jacquard, but by a corresponding number of supplementary needles 147. Each of the latter is provided with a disc at the left-hand end, whilst its right-hand end is supported by the horizontal arm of a steel presser blade 148. And each supplementary needle 147 is encircled by a vertical needle or feeler 149. The upper ends of the feelers 149 are bent to enable them to be supported by a specially formed grate 150 (see plan view and also an enlarged view to the left of the latter in Fig. 390). The grate 150 limits the downward movement of the feelers 149. The lower ends of the feelers 149 pass through holes in the double grate 29.

It will be seen that there are seventeen of the steel presser blades 148, the outer end of each of which is bent downwards as shown, and the whole group arranged to form a grate. The position occupied by this grate of blades is indicated at 148 in Fig. 363 at the end of the slide 59. As the slide 59, Fig. 363, moves outwards due to the action of the parts 25, 55, 56, and 58, the grate 148 at the end of 59 is raised slightly because of the action of the oblique slot 60 on the fixed pin. This upward movement of the part 59 raises the feelers 149, Fig. 390, clear of the endless paper 61. As the griffe 27, Fig. 363, descends, the grate of blades 148 moves inwards, and the bottom ends of the feelers 149, Fig. 390, pass through the double guideplate 29; those feelers which are arrested by blank parts in the endless pilot set remain in the high position, thus placing the right-hand ends of the corresponding supplementary needles 147 in the line of the downward-bent portion of the steel presser blades 148 (see dotted position of one supplementary needle 147 in Fig. 391). On the other hand, those feelers 149, Fig. 390, which pass through holes in the pilot endless paper place the right-hand end of the corresponding supplementary needles 147 opposite the gaps between the steel presser blades 148, Fig. 391. As the

presser blades 148 move nearer to the feelers 149, Fig. 390, some of the supplementary needles 147 will be pushed to the left, and the discs on their ends will move the ordinary needles 146 to the left, and thus take hooks 1, 2, etc., off the knife 27^1 of the griffe, while other supplementary

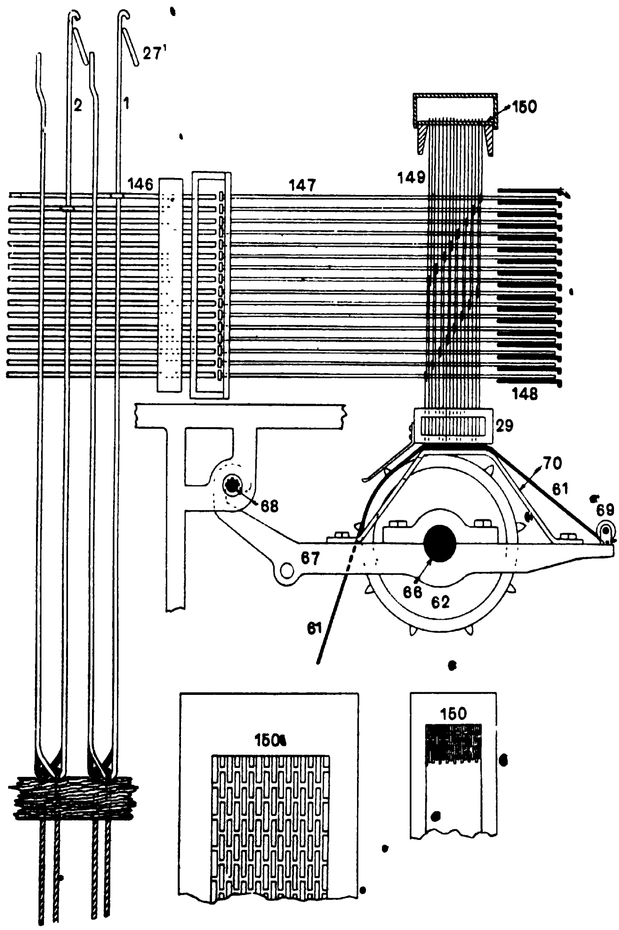


Fig. 390.

needles 147 will pass undisturbed through the gaps near the right-hand ends of the steel presser blades 148, Fig. 391, as the latter are moving inwards; the corresponding hooks 1, 2, etc., Fig. 390, will therefore be raised by the knives 27^1. All the feelers 149 are arranged in a constant pitch; in Fig. 392, however, the circular bends in the

feelers 149 are enlarged slightly in order to show the arrangement better.

Such is the action which takes place when the figure of the design is being cut and while the $\frac{7}{1}$ sateen is being inserted in the figure portion of the repeated endless paper. But to make the fine-pitch jacquard, Fig. 388, work negatively, the steel presser blades 148, Fig. 390, must be inverted as indicated in Fig. 393. Then the holes in the pilot set of endless paper would result in the feelers 149 occupying the low position as usual, but the upward-bent parts of the steel presser blades 148 would push the supplementary needles 147 to the left, and hence leave blanks in the repeated full-harness sets of paper.

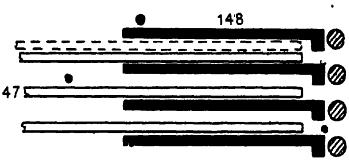


FIG. 391.

Simultaneously, the blanks in the pilot sets of endless cards would cause the ends of all the corresponding supplementary needles 147 to be placed opposite the gaps of the steel presser blades 148, as shown by the dotted supplementary needle in Fig. 393, and therefore all the corresponding hooks, Fig. 390, and cords 34, Fig. 388, would be raised. Now the $\frac{1}{4}$ sateen cards on the cylinder of the coarse-pitch jacquard in Fig. 388 would act in the ordinary way, and would leave down four hooks out of every five. Hence, although every cord 34, Fig. 388, in the ground portion is raised, there is only one cord 146 out of five raised by the coarse-pitch jacquard, so that only one out of five is cut, seeing that two cords (one 34 and one 146) must be raised to cause the corresponding cord 38 to yield.

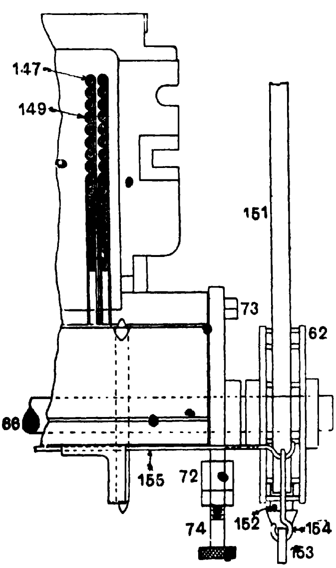


FIG. 392.

Apart from the intricacies of the machine illustrated in Figs. 387 to 393, it will be observed that a defect obtains in that both the ground and the figure weaves are introduced mechanically on to the paper, and thus modifications on the contour of the figure and the adjacent parts of the

ground receive no special treatment. In connection with certain decorative fabrics it is well known that when the weaves are introduced by hand on to the design-paper, the edges of the ornament can be treated so as to yield much more satisfactory results in the cloth than it is possible to obtain by any direct mechanical, electrical, or photographical treatment. On the other hand, there are fabrics in which the above-mentioned treatment is not essential, in which case the machine illustrated in Figs. 387 to 393 appears to be quite suitable.

When the above machine is utilised for repeating purposes pure and simple, the operation can be performed, as already stated, from either long lengths of thin paper (fine Verdol pitch) or from thick cardboard cards of the ordinary type and, of course, of the pitch corresponding to the coarse-pitch jacquard, Fig. 388. If thick cardboard cards are used they would naturally be placed on the square cylinder of the coarse-pitch jacquard on the left-hand side in Fig. 388, and all the hooks of the fine-pitch jacquard on the right of the same figure would be held up while the cutting operation was being performed on the long length of thin paper. Conversely, if the repeating process is from a long length of thin paper as in the fine-pitch jacquard on the right of Fig. 388, all the hooks of the coarse-pitch jacquard on the left would be held up during the repeating process.

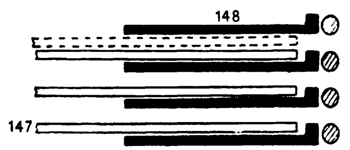


FIG. 393.

The reading-in frames, or "simples," as they are termed, are used in connection with certain machines similar to that illustrated in Figs. 357 to 393, with the object of performing the work, as already stated, without employing a piano card-cutting machine. In this case, however, the simple consists of a number of rows of cords to correspond exactly with the disposition of the rows of the cords in the jacquard—*e.g.* 16 per short row. Before commencing with the selections for the cross cords similar to C and D, Fig. 159, it is usual to pick a thread-and-thread lease of all the vertical cords in the 16 rows, and this operation, as well as that of inserting the cross cords, is not usually performed at the actual cutting machine, but at some more convenient place. When the lease is picked, and two lease rods are inserted, the arrangement is very similar to that illustrated on the extreme right of Fig. 394, where the two lease rods are numbered 156; eight cords only are shown at 157. Provision is made, however, at the upper end of cords 157 to prevent them from becoming displaced; thus the upper end of each cord is made in the form of a loop, and the loop is held by short bars in the reading-in frame. The lower ends

of the vertical cords 157 are attached in a suitable manner to the beam 158, which is held securely by means of a ratchet wheel on the end and a retaining pawl, not shown, but loosely pivoted on a stud in the frame A.

When the simple has been provided with the cross cords as explained

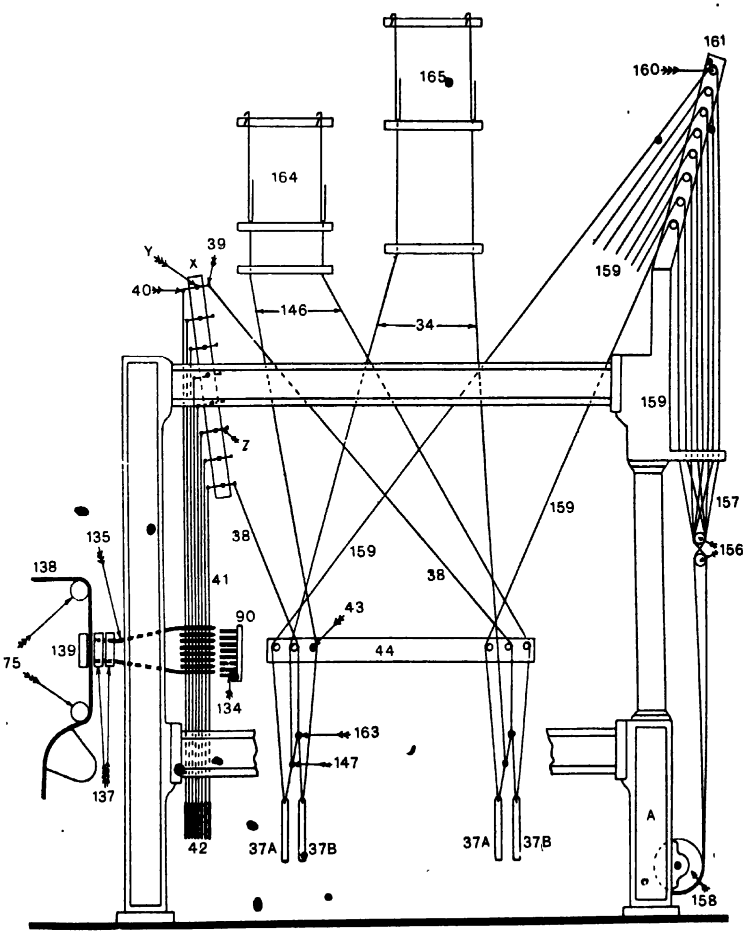


FIG. 394.

in connection with Fig. 159, the simple is taken to the machine illustrated in Fig. 394 and attached as indicated therein. The cords 38, 146, and 34 are attached to the same parts as the similarly numbered cords in Figs. 388 and 389. In Fig. 394, however, there is an extra series of cords 159 which pass over the pulleys 160 housed in the oblique pulley box or frame

161. These cords, the number of which also corresponds with the number of needles in the jacquard, descend as indicated towards the upper ends or loops of the simple cords 157; indeed, the loops of the latter are suspended on hooks at the ends of the cords 159. The lease rods 156 would be removed, and then the cords 157 made taut by rotating the beam 158 clockwise.

Of each short row, or rather half-row, only the first and last cords, 38, 146, 34, and 159, are illustrated in Fig. 394, but all the 16 cards in each complete short row are shown in Fig. 395, in addition to the uniform tensioning cords and lingoes 162. This figure also shows a considerable part of the mechanism, while Fig. 396 is a front view of the same machine, and shows, *inter alia*, one long row of the cords 41 and the lingoes 42.

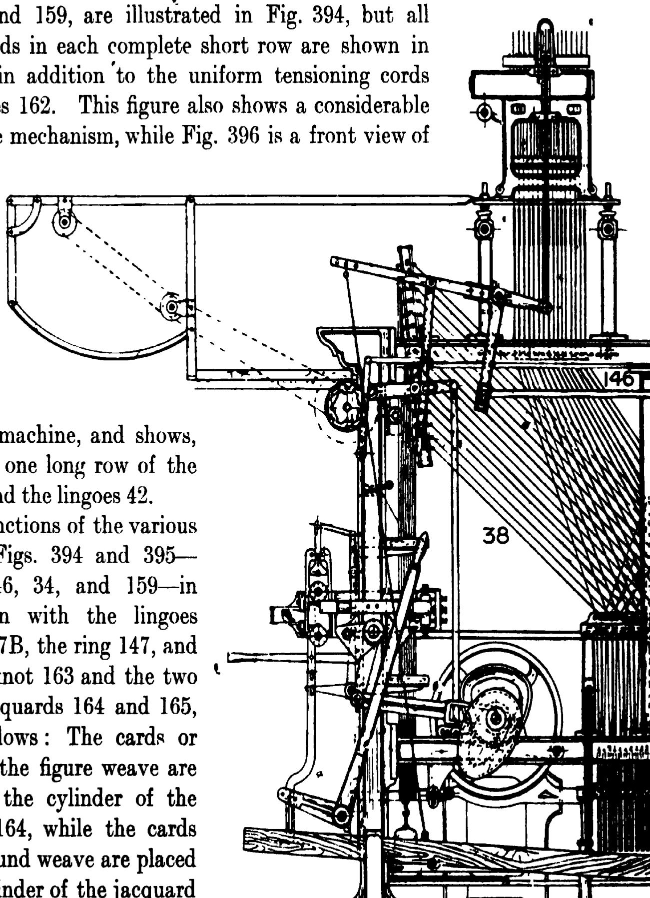


FIG. 395.

The functions of the various cords in Figs. 394 and 395—*i.e.* 38, 146, 34, and 159—in conjunction with the lingoes 37A and 37B, the ring 147, and the large knot 163 and the two 16-row jacquards 164 and 165, are as follows: The cards or paper for the figure weave are placed on the cylinder of the jacquard 164, while the cards for the ground weave are placed on the cylinder of the jacquard 165. The design itself would appear in solid painted masses and solid unpainted areas as represented by the design in Fig. 159, but, of course, on a much larger size of paper. As already mentioned in connection with Fig. 159, the horizontal or cross cords pass under and over the

vertical cords in orders which depend upon the lengths of the unbroken floats of figure and ground, or *vice versa*, according to circumstances.

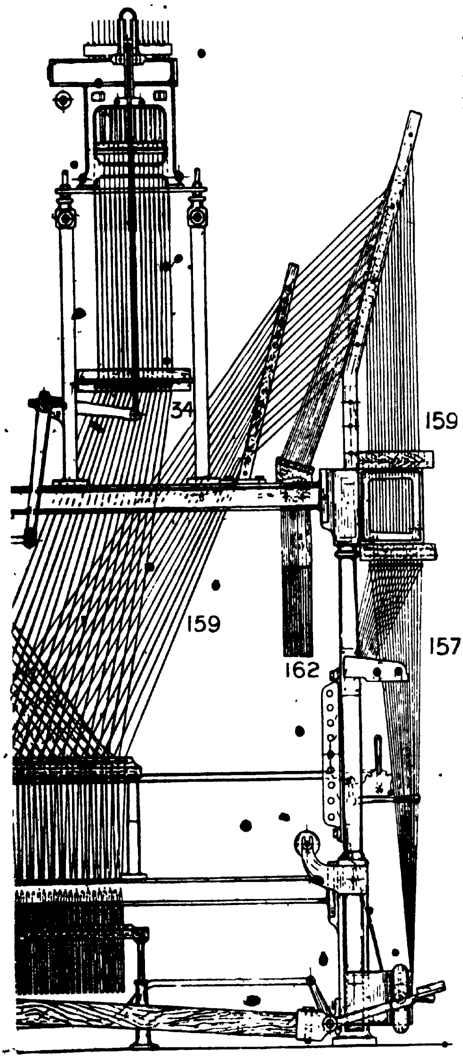


FIG. 395.

The positions of the equal-weighted lingoes 37 A and 37 B affect the position of the punch needles 135, which are similar to those numbered 135 in Fig. 381.

It will be remembered that these punch needles 135 must descend a short distance under the influence of the lingoes 42, Fig. 394, when holes are required in the cards or paper, so that their >-shaped ends may appear in the path of the >-shaped knives 134 of the knife-block 90. If the cord 38 is slackened, a punch needle 135 is lowered ; but if the cord 38 remains as illustrated in Fig. 394, the corresponding grid knife 134 would pass between two adjacent punch needles 135, and a blank would appear in the paper strip 138.

In Fig. 394, and in the much enlarged view of the cords and lingoes in Fig. 397, it will be seen that a comparatively large knot 163 is tied on the cord 38 and on the two short cords 166 and 167, the two latter marked only in Fig 397. The short cord 166 passes from the knot 163 through the ring 147, and is then attached to the lingoe 37 A. The short cord 167 passes direct from the knot 163 to the second lingoe 37 B. Finally, the cord 38 passes, as before, to one end 39 of the wire Z, Fig. 394. The other end 40 of wire Z is attached to a cord 41, and the wire Z is fulcrumed at Y.

It will be understood that all the cross cords, C and D, etc., in Fig. 159

are supposed to be interwoven with the vertical cords 157, Fig. 394. If, therefore, an iron rod is inserted between these vertical cords 157 so as to replace the first or upper cross cord, and then this iron rod is made, either mechanically or manually, to pull the vertical cords apart so as to make, so to speak, a shed, as partially indicated in Fig. 395, the cords 157 thus pulled out of their direct line would obviously raise the corresponding lingoes 37 A, through the medium of the cords 159. This movement, although representing all cords pulled for the figure on the first pick, would have no effect upon the knots 163, and hence no effect upon the cords 38 or the cords 41. But if the corresponding hooks in the jacquard 164 be lifted at the same time, through cords 146, then both companion lingoes 37 A and 37 B would be raised simultaneously, and the corresponding cords 38 and 41 slackened, thus lowering the punch needles 135 to be pushed to the left and through the paper 138 by the moving grid knives 134. It is not difficult to see, however, that under such circumstances the cutting on the paper 138 would coincide with the long painted floats of the design paper. On the other hand, if certain hooks in these groups in the jacquard 164 are prevented from rising, their corresponding lingoes 37 B would remain down, and hence blanks would appear at these points on the paper 138, because one lingoe 37 A is unable alone to slacken cord 38. Consequently, if the figure on the paper 138 requires to be punched so as to develop the 8-thread sateen, $\frac{7}{1}$, it would be necessary to place a set of cards or paper cut for this weave on the cylinder of jacquard 164. Any other weave for the figure could be obtained by a suitably punched set of cards for the jacquard 164.

It is desirable to cut the weave for the ground simultaneously with the cutting of the weave for the figure, and this is effected by means of the 16-row jacquard 165, the cords 34, the knot 163, and the ring 147. The knot 163 is made large enough to prevent it from passing through the hole of the ring 147; hence if a cord 34 is raised by a hook of the jacquard 165, the ring 147, on being raised, would just slide upwards a short distance on the cord 166, Fig. 397, and then raise cord 38 by coming into contact with the knot 163. The lingoes 37 A for the ground part have, of course, not been affected by the lifting of the lingoes 37 A for the figure part, and hence the cords 166 belonging to these low-positioned lingoes 37 A would be taut; but both lingoes 37 A and 37 B would be raised by means of the ring 147 and the knot 163, and consequently the corresponding cords 38 and 41 would be slackened to enable a hole to be punched for the ground. If cards for the ground weave, say $\frac{1}{4}$, be placed in the cylinder of the jacquard 165, this weave would be punched on the ground parts of the paper 138 simultaneously with the punching of the $\frac{7}{1}$ sateen weave for the figure.

Any two weaves, one for the figure and one for the ground, can be punched at the same time on the thin paper 138; the making of the point-paper design would be of the simplest possible nature; while the selection of the marks for the insertion of the cross cords or picks in the simple would also be easily performed.

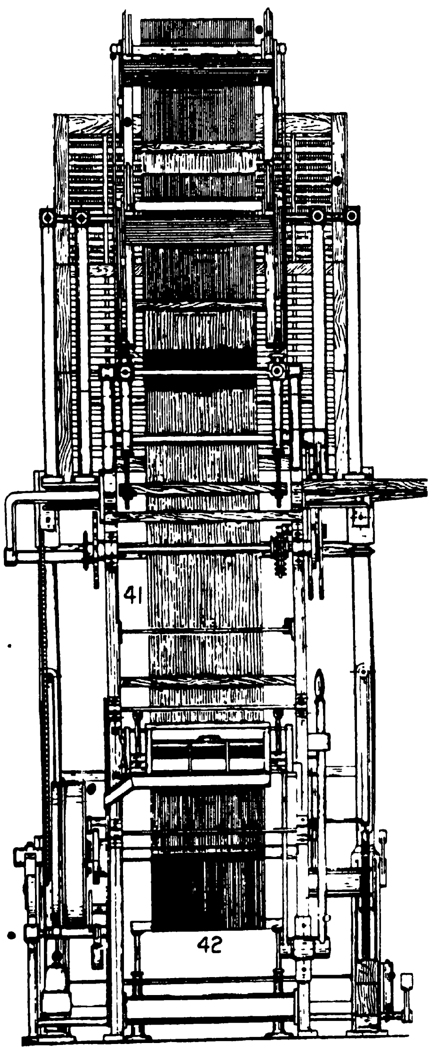


FIG. 396.

Although, say, every fifth cord 34 (Fig. 394) is raised by the jacquard 165, it does not follow that all such cords are capable of lifting the corresponding knots 163 and lingoes 37 B, for some of the latter may be required down for the figure binding. For those cords that are required down, the lingoes 37 B would be in the low position, but the companion lingoes 37 A would, of course, be up, because of the pulling of the cords 156; hence the cords 166, Fig. 397, belonging to this group would be slack, and the effect of lifting the rings 147 by means of the cords 34 would simply cause the rings to slide on, and take up, the slack cords 166.

Another arrangement of the bottom cords and lingoes is illustrated in Fig. 398. In this case, each punch needle 135, Fig. 394, is connected, through the necessary cords, to three weights, 37 A, 37 B, and 37 C, Fig. 398, the weight 37 A being about twice as heavy as either weight 37 B or weight 37 C. The heavy weights 37 A are lifted by the cords 159, Figs. 394 and 395, when the cords 157 of the simple are deflected by the operative; and

when the lighter weights 37 B are lifted by the cords 146 from the jacquard 164, the needle punches 135, Fig. 394, are lowered by the cords 41.

In Fig. 398, mails 163 replace the knots 163 and rings 147 in Figs. 394 and 397. The weight 37 A is connected to the cords 157 of the simple by the cords 159, and a shorter cord 167 passes from the weight 37 A, over the glass rod 169, and then to the light weight 37 B. A third cord 168 passes from the weight 37 A through the mail 163 and to the third weight 37 C. The weights 37 B are connected directly by cords 146 to the hooks of the jacquard 164 for the figure, and the weights 37 B are also connected through the mails 163 and the cords 38 to the needle punches 135, Fig. 394. Finally, the third weights 37 C are connected directly to the hooks of the jacquard 165 by means of cords 34.

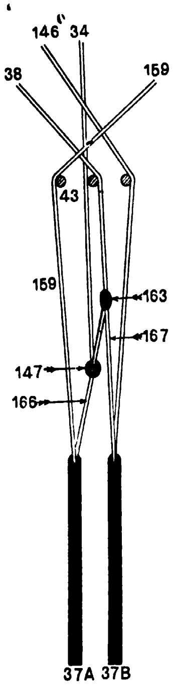


Fig. 397.

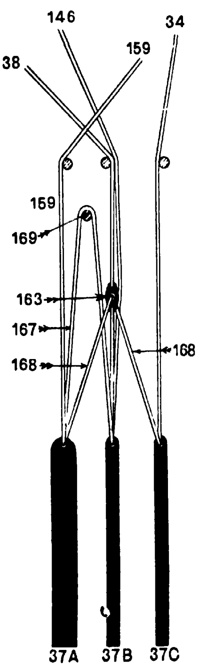


Fig. 398.

When the simple cords 157, Figs. 394 and 395, are pulled, the cords 159 and the heavy lingoes 37 A, Fig. 398, are lifted. The upward movement of a lingoe 37 A causes a slackening of cords 167 and 168 without affecting the corresponding needle punch 135, Fig. 394, as this is held in the inoperative position by the weight 37 B. Hence, to obtain the necessary weave in the figure portion, it is essential to lift simultaneously the cords 159 and all the cords 146 and lingoes 37 B which are not required to be down for the figure weave. The remaining needle punches are for the ground, and are left in their normal positions because the corresponding heavy weights 37 A are not disturbed by unpulled cords 159.

In order to cut the ground weave in the parts corresponding to the unpainted portions of the point-paper design, the cylinder of the jacquard 165 is provided with a set of cards, say, 1 up and 4 down, or any other order, and hence the hooks of the jacquard 165 would lift every fifth cord 34 and every fifth weight 37 C. The lifting alone of these cords 34

and weights 37 C does not affect the needle punches 135, but when this lifting action takes place, the corresponding short cords 168 are slackened, and the heavy weights 37 A draw up the slack and simultaneously draw

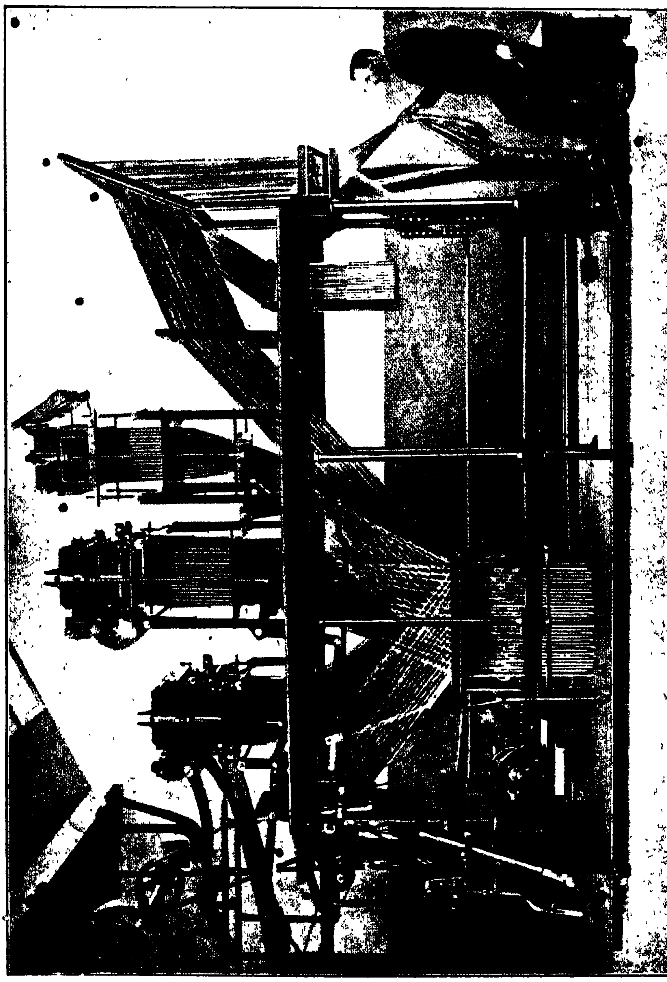


Fig. 399.

up the lighter weights 37 B. Hence, cords 38 are slackened, and these allow the needle punches 135, Fig. 394, to fall into the path of the moving grid knives 134 to effect the cutting of the holes for the ground weave.

Fig. 399 illustrates the operative at work. He is at present holding

out a certain number of simple cords—corresponding to the painted portions on one horizontal line or pick of the point-paper design—for the first pick. All the other cross cords, interwoven with the vertical cords of the simple, are shown in a body nearer the floor. The foot treadle actuates, by levers and rods, the lifting and punching mechanism (see also Fig. 395); after the paper has been punched by the mechanism on the left for one pick, the mechanism is disengaged automatically so that the attendant may pull the next cross cord for the second pick, and so on. Two or more simples may be provided, in order that one or more may be in preparation while others are in use at the machines. If actual

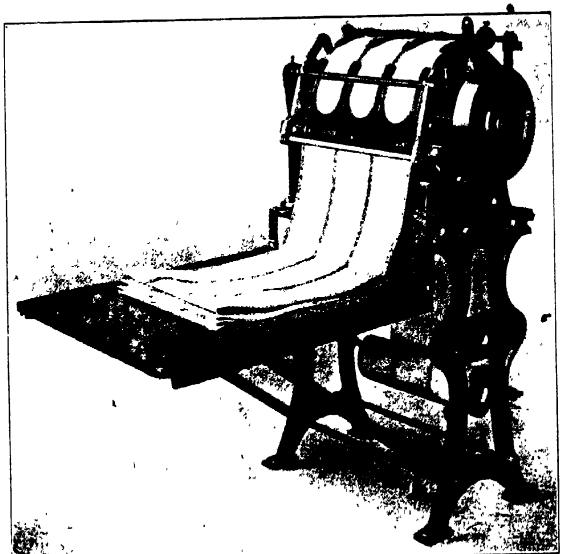


FIG. 400

repeating is to be performed, the pilot paper strip is placed on the left of Fig. 399, and the hooks of this machine operate the needle punches as before.

After the long paper strip has been punched, it is usually supported on a light card cradle by means of small projections on light metal clips, a doubled part of which grips the paper. In order that the paper may be prepared correctly for the machines, especially when long lengths are used, it may be creased by a machine as indicated in Fig. 400 before it is taken to the card-cutting or repeating machine.

A somewhat similar method of reading-in is employed in connection with the cutting of pasteboard cards on the Vincenzi pitch. Fig. 401

illustrates one type of machine for the purpose, and it will be seen that there are two simples connected by suitable cords to the repeater or puncher on the right. We have seen cards (strawboard cards) cut with this pitch on a piano card-cutting machine, and then the loom cards repeated from the common strawboard cards on the repeater on the right.

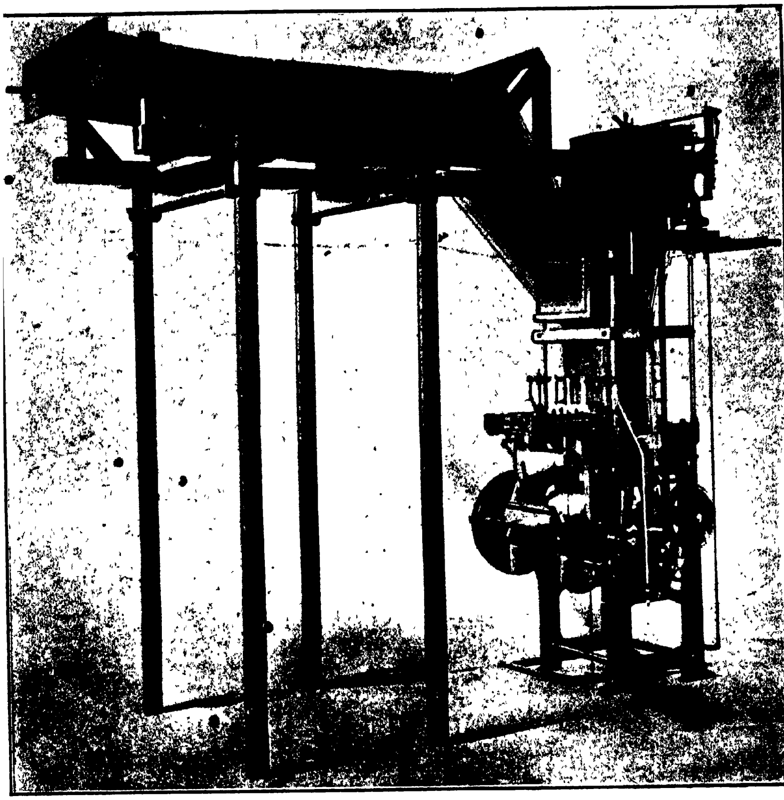


FIG. 401.

The usual French machine for the Vincenzi pitch is shown in Fig. 402, and, so far as the general arrangement of the cords is concerned from the jacquards and simple, is very similar to the machine illustrated in Figs. 394 and 395. The simple is omitted in Fig. 402, but its position is on the extreme right. This machine is usually arranged for 1320 needles, and requires two operatives. One operative draws the cords of the simple on the right, and, as already described, while the other operative performs

the actual punching operations on the left. The actual cutting apparatus differs, however, from that illustrated in Figs. 394 and 395, although it

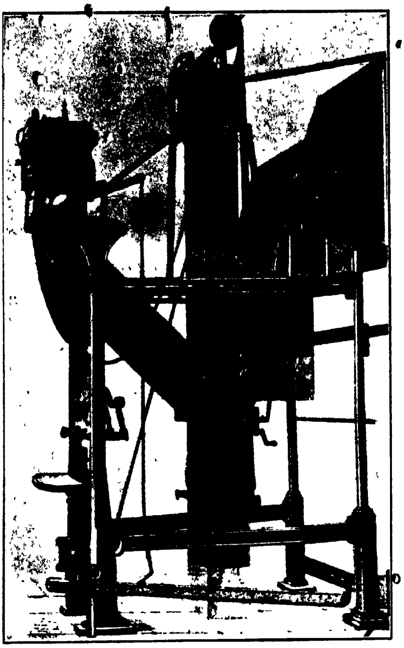


Fig. 402.

is very similar to, but finer than, the punching parts illustrated in Figs. 302 to 305 in connection with the Devoge repeater.

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THE END

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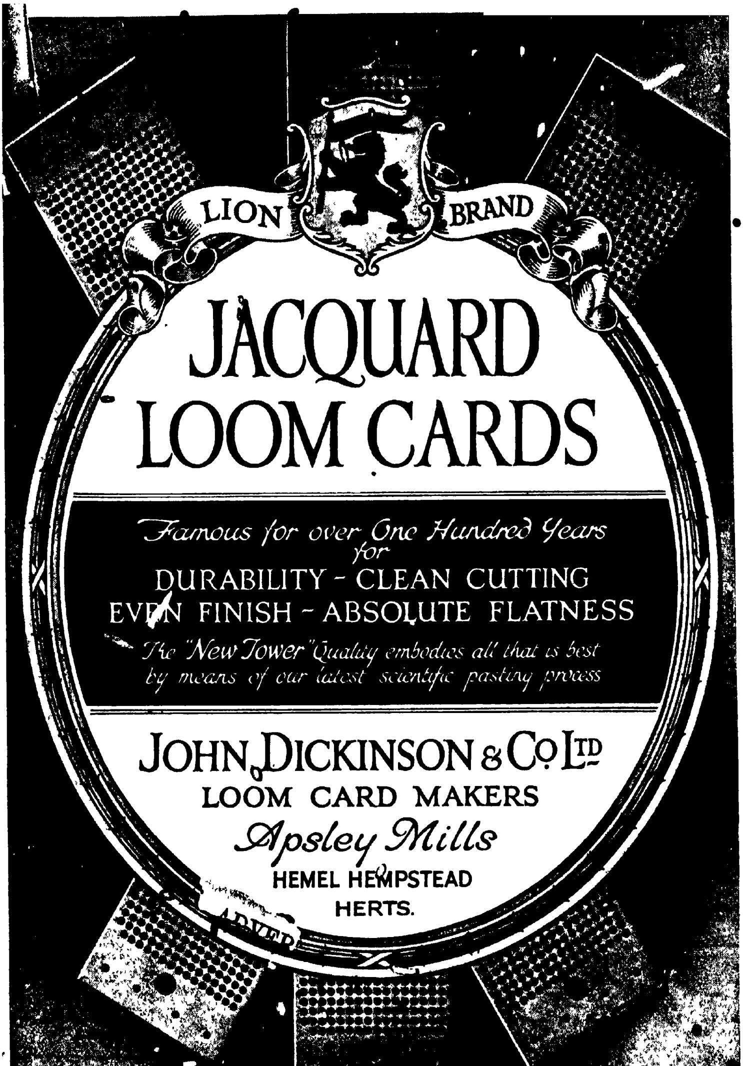
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